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MECHANICAL ENGINEERING

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IN THIS NUMBER

A.S.M.E. SPRING MEETING PAPERS

The Hydraucone Regainer, Its Development and Applications in Hydroelectric Plants
By W. M. White

Recording Ash-Pit Loss from Chain-Grate Stokers
By E. G. Bailey

Road Building and the Mechanical Engineer

Requirements of the Engineering Industries and the Education of Engineers
By M. W. Alexander and D. C. Jackson

The Rise of Industrial Workers
By Ira N. Hollis

JUNE 1921

THE MONTHLY JOURNAL PUBLISHED BY THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

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Volume 43 June, 1921 Number 6

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Contributors and Contributions

Spring Meeting Papers

In the present intense consideration of hydraulic power development, engineering interest is at once caught and held by a device which will more efficiently utilize hydraulic energy. In his paper on the Hydraucone Regainer, William M. White, Manager and Chief Engineer of the Hydraulic Department of the Allis-Chalmers Manufacturing Company, explains a device, which provides a means for efficiently recovering the energy discharged from the hydraulic turbine runner. Mr. White has served as hydraulic engineer in his present capacity with the Allis-Chalmers Company since 1907. From 1901 until that time he was in the employ of the I. P. Morris Company, being in charge of their hydraulic department from 1903. He received his degree from Tulane University and later spent two years at the University of Alabama, in post-graduate work.

WILLIAM M. WHITE

As part of the session to consider the efficient burning of Mid-West coals, E. G. Bailey of Cleveland presented his paper on Recording Ash-Pit Loss from Chain-Grate Stokers. Mr. Bailey is president of the Bailey Meter Company and has been engaged in the manufacture of apparatus for recording boiler performance. He is a graduate of Ohio State University and since leaving that institution his time has been devoted almost entirely to work connected with the developing of mechanical methods of burning coal, four years having been spent with the Fairmont Coal Company, two years with A. D. Little, and later years with the Fuel Testing Company and as president of the Bailey Meter Company.

The papers presented at the Materials Handling Session were arranged to attract the interest of the road-building contractor and the mechanical engineer who designs and manufactures machinery for his use. The speakers at this session were men whose names stand high in the road-building field. B. H. Piepmeier is engineer of construction of the Illinois Division of Highways. R. C. Marshall, Jr., is general manager of the Association of General Contractors of America, and C. D. Curtis is assistant to the Chief of the Bureau of Highways in the Department of Agriculture.

The Industrial Worker

Dr. Hollis' address, presented before a New York meeting of engineers and printed in this issue of MECHANICAL ENGINEERING, deals in a very interesting way with the vital question of industrial relations. The rise of the industrial worker is considered under several headings, but Dr. Hollis emphasizes particularly the broadening of opportunity and the necessity to the workman of satisfaction with his job. The realization on the part of the engineering profession tha the industrial problem requires special analytical treatment, should make this contribution by Dr. Hollis of value to every engineer. It will stimulate thought, and careful straight thinking is indeed a prime requisite to the statement and solution of industrial problems.

Education

On April 22 the Metropolitan Section of the A.S.M.E., jointly with the New York Section of the A.I.E.E., devoted its meeting program to the consideration of engineering education. This meeting is reported in this issue of MECHANICAL ENGINEERING. At the Spring Meeting, however, there was a presentation of a solution of the educational problem of the engineering school in relation to the engineering industry, in the form of a paper by Magnus W. Alexander and Dugald C. Jackson. Mr. Alexander at present is managing director of the National Industrial Conference Board but served until recently as consulting engineer for the General Electric Company at West Lynn. In this capacity he worked out with Dugald C. Jackson, professor of electrical engineering at Massachusetts Institute of Technology the scheme outlined in the paper. Mr. Alexander received his early education in Austria and his subsequent technical training in the works of the Westinghouse Electric Co., and the General Electric Co. Professor Jackson is a graduate of Pennsylvania State College and served as professor of electrical engineering at the University of Wisconsin until 1907, when he became professor of electrical engineering at Massachusetts Institute of Technology. Professor Jackson is an electrical engineer of international repute.

The July Issue

In addition to a complete account of the Spring Meeting sessions at Chicago, the July MECHANICAL ENGINEERING will carry two of the papers presented at the Railroad Session, those by Messrs. Snyder and Stuebing. The paper by Mr. Haig presented at this session was published in the May issue. In addition there will be a report from one of the Sub-Divisions of the Engineering Division of the National Research Council on the Hardness Testing of Metals. This report will be of considerable value as it shows a new method for more accurately measuring the hardness of metals. It is planned also to feature one or more of the inspiring addresses delivered at the Spring Meeting.

A.S.M.E. Passes 14,000 Mark

The activities of a Society of over 14,000 engineers furnish the material for a vitally interesting part of MECHANICAL ENGINEERING. Section II of the June issue, devoted to Society Affairs, carries accounts of the work of the Professional Divisions, Local Sections, Student Branches and various committees. Reading Section II will make clear to any one the broad scope and importance of the work of the Society.

This issue of "Mechanical Engineering" has been delayed on account of the printing situation.

MECHANICAL ENGINEERING

Volume 43 June, 1921 Number 6

The Hydraucone Regainer, Its Development and Applications in Hydroelectric Plants

By W. M. WHITE,[1] MILWAUKEE, WIS.

Those familiar with hydroelectric power-house operation where curved draft tubes are employed cannot have failed to notice the boiling and disturbance of the water at the outlet from curved tubes, which disturbance is clearly an evidence of inefficiency and loss of energy. The device described in this paper—the hydraucone regainer—provides a means for efficiently recovering the energy discharged from the runner for useful effect on the water wheel within the limited space available in the power-house foundations.

This new method of regaining pressure from velocity of fluids in motion consists in causing the stream flow to impinge upon some definite shape, either flat, conical or concave, thus changing its direction, and then placing an envelope around this shape so formed upon the particular base used, which envelope conforms to the shape of the fluid at entrance and gradually recedes from what would be the normal or free shape of the non-enclosed fluid upon the particular base used; the effect of this gradually diverging envelope being to change the velocity head of a fluid flowing at high velocity into its entrance into pressure and low velocity at its exit.

The field of application of the hydraucone regainer, according to the author, will be greater on low-head plants, although it is now being installed in connection with two 40,000-hp. units which are to operate under a head of 421 ft. Hydraucone regainers are now in operation or in course of construction in a number of plants to operate under heads varying from 8 ft. to 421 ft. and with water wheels developing from 150 to 40,000 hp.

The paper gives very complete particulars of the long series of experiments resulting in the development of the hydraucone regainer, as well as data of a series of tests made at the Holyoke Testing Flume, showing the increase in power-plant efficiency obtained by its use.

"HYDRAUCONE" is a new word coined for convenience in referring to the new method of transforming velocity head of fluids in motion into pressure head. This method consists in causing the stream flow to impinge upon some definite shape, either flat, conical or concave, thus changing its direction, and then placing an envelope around the shape so formed upon the particular base used, which envelope conforms to the shape of the fluid at entrance and gradually recedes from what would be the normal or free shape of the non-enclosed fluid impinging upon the particular base used; the effect of this gradually diverging envelope being to change the velocity head of a fluid flowing at high velocity into its entrance into pressure and low velocity at its exit. The angle of divergence of the envelope from the normal or free shape of the impinging fluid is such as to bring about the same phenomena of flow conditions as result in an expanding straight-axis tube such as the discharge end of a venturi meter. The new method therefore provides a means for transforming velocity head into pressure head within a short distance measured along the axis of the inflowing stream, and has useful application in water-power plants, supplanting the usual curved draft tube and providing for higher efficiencies with a minimum of excavation. For clearness reference is made in this discussion only to the single-Francis-runner vertical water wheel unless otherwise stated.

[1] Manager and Chief Engineer Hydraulic Department, Allis-Chalmers Mfg. Co.

Abstract of a paper presented at the Spring Meeting, Chicago, May 23 to 26, 1921, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Copies of the complete paper may be obtained on application. All papers are subject to revision.

The draft tube of a water wheel serves two purposes. The first of these is to maintain at the discharge side of the runner passages a suction action equivalent to the difference in elevation between the runner and the level of the tail water, thereby providing for the use of the total head. The second purpose is to transform the velocity head in the water as it is discharged from the runner into pressure head by the time the water reaches the end of the draft tube, and thus maintain at the discharge side of the runner passages a suction action greater than that which would be caused by the difference in elevation between the runner and the level of the tail water.

At first thought it seems like attempting to lift oneself with one's bootstraps to endeavor to utilize the energy in water after it has left the water-wheel runner, but this utilization may be effected by an efficient transformation of the velocity head in the water discharged from the runner into pressure head, which causes an increased suction action at the runner and thus maintains a greater head acting on the runner than the total head as measured between the equivalent water level of the water at entrance to the water wheel and the level of the water in the tail race.

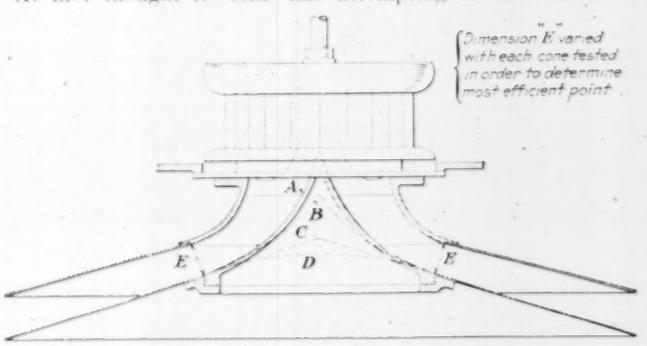

FIG. 1 HYDRAUCONE REGAINERS WITH CONE CENTERS AND CONICAL PLATES

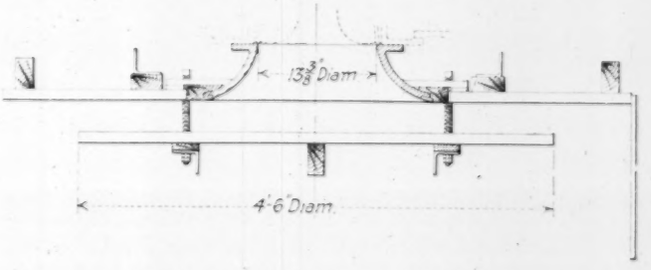

FIG. 2 HYDRAUCONE REGAINER WITH FLAT PLATE

The necessity for an efficient means for regaining pressure from velocity of the water discharged from the water-wheel runner in modern power plants has been brought about by the ever-increasing demand for higher speeds of water wheels for given conditions of power and head. The cost of electric generators of such sizes and speeds as are usually employed in water-power plants varies inversely as the speed, hence the buyer maintains a constant urge for higher water-wheel speeds, to meet which many high-speed types of runners have been brought out. As the specific speed of a

runner increases, the percentage of energy it discharges also increases. A runner of moderate specific speed discharges water with such velocity that the energy contained in the water as velocity head is about 10 per cent of the energy of the total head; and runners of highest specific speeds discharge the water at such velocity that the energy contained in it as velocity head is from 20 per cent to 25 per cent of the energy due to the total head acting on the water wheel. In order to secure high efficiency with high-speed runners it is therefore vital to regain the major portion

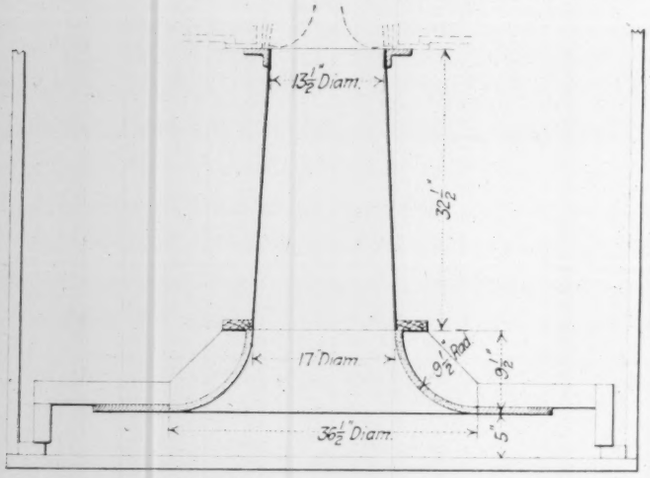

Fig. 3 Combination of Straight Draft Tube and Hydraucone Regainer with Flat Plate

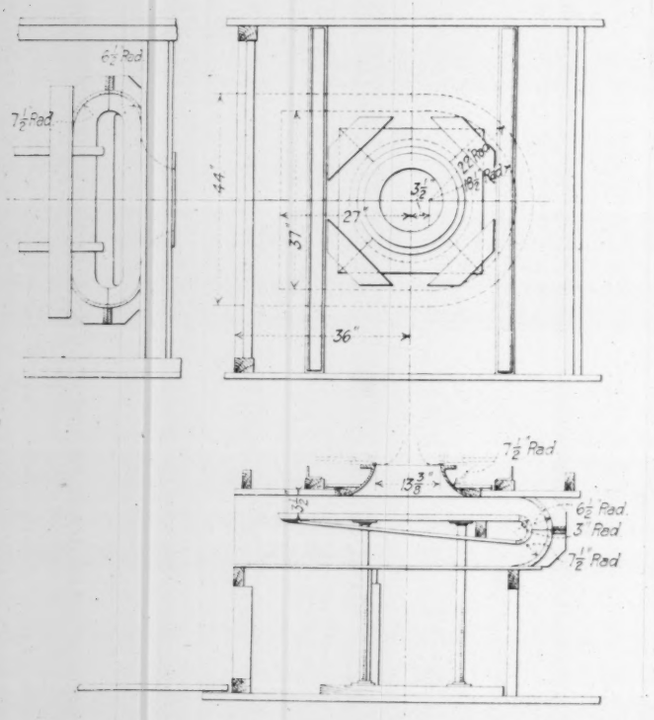

Fig. 4 Dimensions of Model of Hydraucone Regainer Used in a Number of Power Plants

of the energy contained in the water discharged from the runner for useful effect upon the water wheel, for as more of the energy which is discharged from the runner is regained, the efficiency of the water-power plant is increased.

A good illustration of the necessity for a better means of regaining the energy discharged from water-wheel runners is afforded by the installation at the Aluminum Company of America's plant at Massena, New York, where five 6000-hp. vertical two-runner water-wheel units are installed. Efficiency was of great importance, and the contract was placed with the manufacturer upon a bonus and penalty basis for efficiency, this being $6000 for each per cent of efficiency per unit. The contract value of 1 per cent increase in efficiency in this development was therefore $30,000. Very elaborate tests were conducted by the Aluminum Company of America to determine the efficiency of these water wheels, the final results of which showed that the guaranteed efficiency was exceeded by about 2 per cent, yet the efficiency could have been increased very much more had a better form of draft tube been installed.

Experimental Work Resulting in the Development of the Hydraucone Regainer

The necessity for a more efficient means of regaining pressure from velocity and changing the direction of flow from the water wheel within the limited space available in power-house foundations led the writer to undertake a long series of experiments resulting in the development of the hydraucone regainer as set forth in the following pages.

A hydraulic laboratory was installed in a garage near the corner of Second and Wright Streets, Milwaukee, the essential equipment of which was as follows:

A water box 6 ft. wide, 5 ft. 6 in. high, and 32 ft. long
A centrifugal pump of 14 in. discharge diameter, belt-driven by a 25-hp. motor which served to supply a maximum of 14 cu. ft. per sec. of water against a maximum head of about 15 ft.
A supply pipe leading from the centrifugal pump to a 42-in. diameter cylindrical plate-steel water-wheel casing with side inlet
A water wheel equipped with wicket guide vanes
A high-speed runner, being a 9-in. model of type No. 13, Allis-Chalmers Mfg. Co. The discharge diameter of the runner where it joins the draft tube is 13⅜ in. Specific speed, 90 (English system)
Also a prony brake, a tachometer, various pitot tubes, gages and manometers, etc.

The output of the water wheel under good testing conditions was about 8 hp., so that the size of the equipment was sufficient to give a practical demonstration of the relative efficiencies of the draft tubes, hydraucone regainers and other devices tested.

A great many tests were made with many objects in view, and comprised tests with no draft tube; tests of straight conical and short curved draft tubes; Argo and Mio curved draft tubes; hydraucone regainers with cone centers, with conical plates, and with flat plates; a combination of straight draft tube and hydraucone regainer with flat plate; and a power-house model of a hydraucone regainer.

The hydraucone regainers with cone centers are shown at *A* and *B* in Fig. 1, and the hydraucone regainer with conical plates at *C* of the same figure. The hydraucone regainer with flat plate is shown in Fig. 2.

Fig. 3 shows a combination of a straight draft tube with a hydraucone regainer having flat plates. This type, now frequently employed, was the one installed at Niagara Falls, as will be more fully described later. Fig. 4 gives the dimensions of a model of hydraucone regainer such as has been installed in several power plants now in operation.

Figs. 5 and 6 show respectively the test curves plotted from the results of data obtained in the tests of the models of the Argo draft tube No. 1 and the hydraucone regainer with flat plate. It will be noted that the test results were all reduced to a basis of 1 ft. head before the results were plotted. Examination of these curves should convince any one that the tests must have been carefully conducted, and that the results may be relied upon to give at least a fair comparison of the relative efficiencies of the various devices tested. The identical water wheel, equipment, and setting were used in all these tests.

Fig. 7 shows a series of efficiency curves plotted between horsepower and efficiency from test curves similar to those illustrated in Figs. 5 and 6. These curves give the efficiencies obtained at constant speed of the turbine throughout the range of the curves. The speed at 1 ft. head is indicated in the figure by the abbreviation r.p.m.$_1$. The speed at best efficiency is different for each curve.

It will be noted that the more efficient the regaining device, the higher the speed as well as the higher the power of the water wheel. It will further be noted that the increase of efficiency from "no draft tube" as shown in curve 1 to "hydraucone regainer" as

shown in curve 5 is from 77½ per cent to 86 per cent, with an increase in speed from r.p.m.$_1$ = 155 to r.p.m.$_1$ = 165, and with a maximum power from hp.$_1$ = 0.270 to hp.$_1$ = 0.310. The great gain, therefore, by the use of hydraucone regainers is not only in higher efficiency but is also in both speed and power.

Curve 1, Fig. 8, shows the efficiency of the short curved draft tube, which, it will be noted, is less than with no draft tube at all. There is no question but what many plants in operation today are losing power because of the poor curved tubes they use.

Curve 5, Fig. 8, shows the efficiency of the power-house model of hydraucone regainer whose dimensions are given in Fig. 4 and are approximately the same as those of the hydraucone regainer installed at the Hiram plant of the Cumberland County Power & Light Company, Portland, Maine.

Curve 4 gives the results of a test of a plate-steel curved draft tube that are very creditable, but it is very rare that there can be installed in a power house a draft tube of the same relative dimensions as those of the model employed, for the cost of excavation would be prohibitive.

Fig. 9 gives the results of tests with the hydraucone regainers shown in Fig. 1 and also with the straight tube and hydraucone regainer illustrated in Fig. 3. These curves are plotted from elaborate tests similar to those of Figs. 5 and 6 and show clearly that the hydraucone regainers with flat plates are slightly more efficient when tested with the model turbine than those with cone centers.

Fig. 10 presents the results of tests made on various shapes of conoidal chambers, from which it will be seen that the hydraucone regainer as here discussed is susceptible of a reasonable variation without materially affecting its efficiency.

The early tests at the laboratory were made to determine the effects on the model water wheel of radial passages extending outward but with a slight angle downward from the horizontal, and with passages leading directly from the runner. These early tests were not so successful as the later tests because it was not then realized that in order to change the direction of the water from axial as it flowed from the runner to radial and outward, it was necessary to take into consideration and provide for what was afterward called the "hydraucone action" of water, which requires a definite curvature to properly change the direction of the water from axial to radial if the greatest regain of velocity head is to be expected and consequent losses are to be avoided. In searching for a means for increasing the efficiency of regain the author recalled some experimental work done in connection with the determination of the pitot-tube formula in 1900, the results of which were published in Vol. 22 of the Journal of the Association of Engineering Societies (1901), page 284. Fig. 21 of that publication shows the stream lines and velocities of a jet impinging upon a plate, and by reason of the importance of the principle there disclosed in the new method of regaining pressure from velocity, it is reproduced here as Fig. 11.

The lines in this figure represent the stream lines of flow of the water, which were traced by injecting a small stream of blue water into the jet at various points along a diameter and noting and recording the flow line. The plate employed in this case was made of glass in order to afford ample light for making the observations. The figures given in the circles represent the velocities in feet per second at the various locations indicated. It will be noted that the water at the center of the jet slows up as it reaches the plate and delivers its velocity head into pressure head at the center of the plate. This pressure head at the center is transformed into velocity as this stream flow passes from the center of the point of impingement to the point beyond the radius of curvature. Referring to

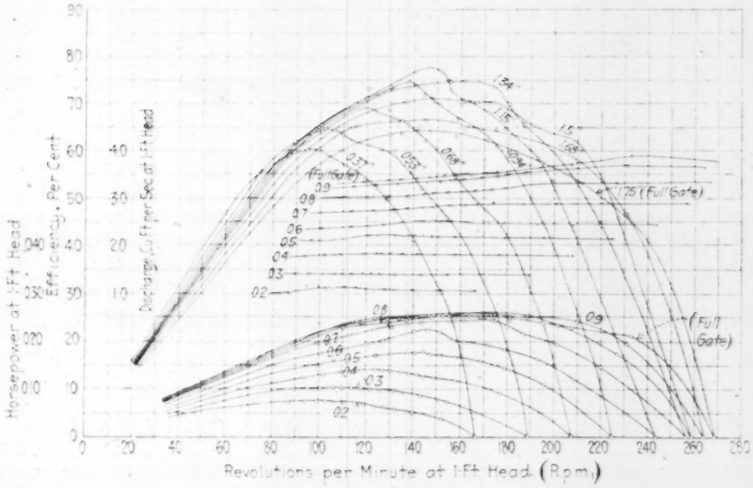
Horsepower at 1-Ft Head
Efficiency, Per Cent
Discharge, Cu Ft per Sec at 1-Ft Head
Revolutions per Minute at 1-Ft Head (R.p.m.)
(Full Gate)

FIG. 5 CURVES OF TEST OF MODEL OF ARGO CURVED DRAFT TUBE NO. 1

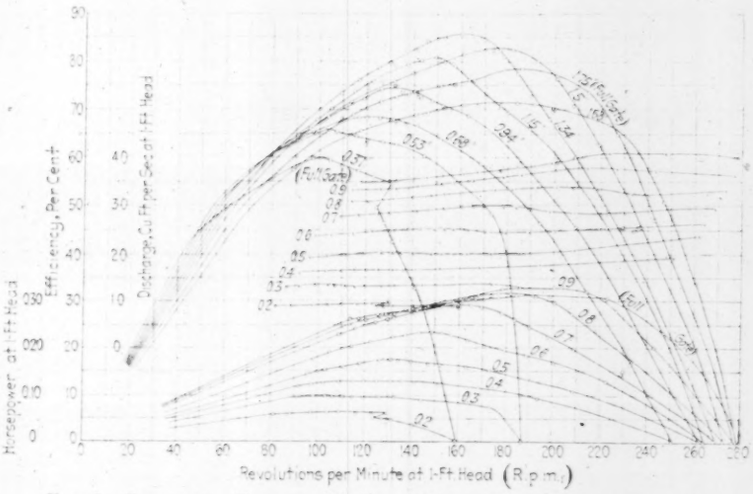
Horsepower at 1-Ft Head
Efficiency, Per Cent
Discharge, Cu Ft per Sec at 1-Ft Head
Revolutions per Minute at 1-Ft Head (R.p.m.)
(Full Gate)

FIG. 6 CURVES OF TEST OF MODEL OF HYDRAUCONE REGAINER WITH FLAT PLATE

(7½-in. radius conoidal chamber, 4 ft. 6 in. in diameter)

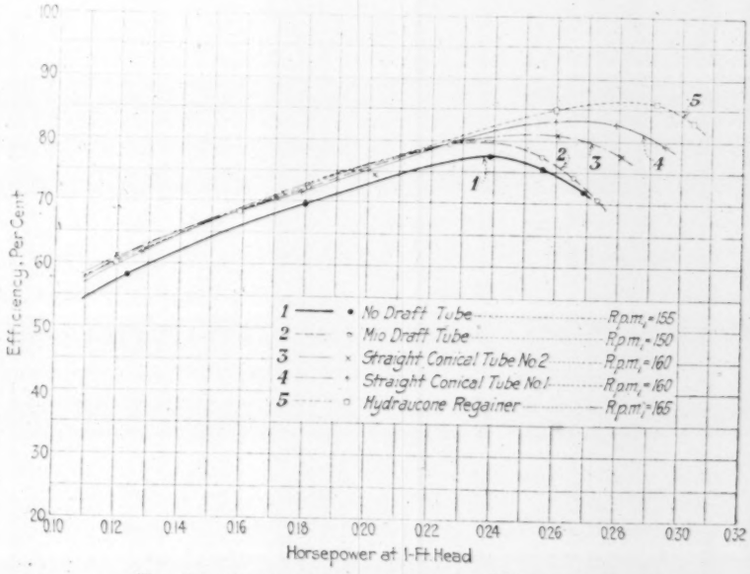
Efficiency, Per Cent
Horsepower at 1-Ft Head
1 — • No Draft Tube R.p.m.₁=155
2 - - ○ Mio Draft Tube R.p.m.₁=150
3 — × Straight Conical Tube No 2 R.p.m.₁=160
4 — · Straight Conical Tube No 1 R.p.m.₁=160
5 — ○ Hydraucone Regainer R.p.m.₁=165

FIG. 7 CURVES SHOWING RELATION BETWEEN EFFICIENCY AND HORSEPOWER AT 1 FT. HEAD

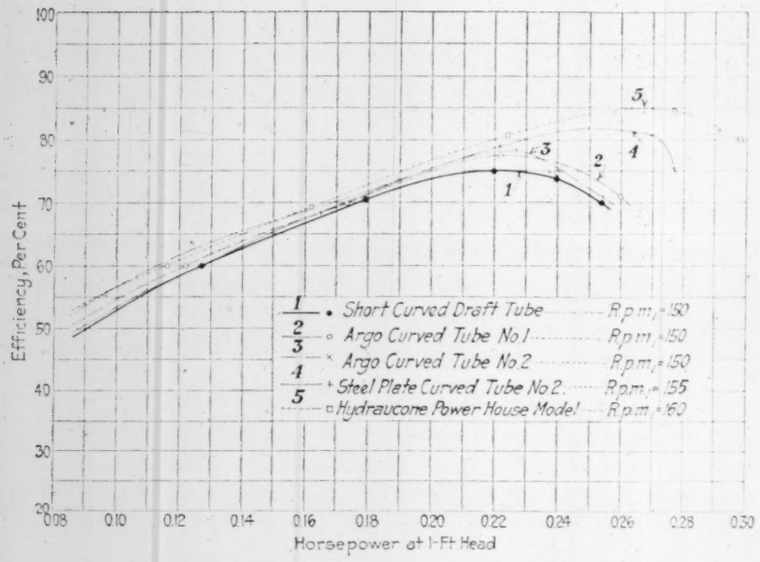
Efficiency, Per Cent
Horsepower at 1-Ft Head
1 • Short Curved Draft Tube ..... R.p.m. = 150
2 ○ Argo Curved Tube No. 1 ..... R.p.m. = 150
3 × Argo Curved Tube No. 2 ..... R.p.m. = 150
4 + Steel Plate Curved Tube No. 2 ..... R.p.m. = 155
5 □ Hydraucone Power House Model ..... R.p.m. = 160

FIG. 8 CURVES SHOWING RELATION BETWEEN EFFICIENCY AND HORSEPOWER AT 1 FT. HEAD

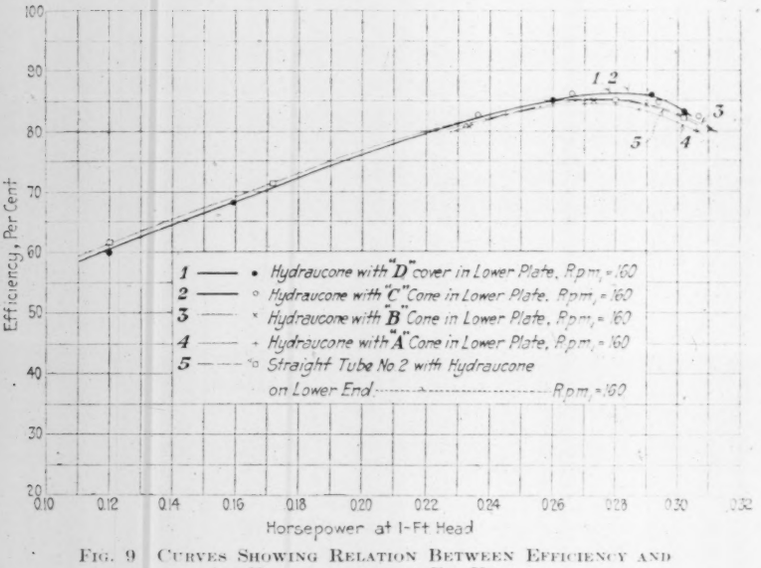
Efficiency, Per Cent
Horsepower at 1-Ft Head
1 • Hydraucone with "D" cover in Lower Plate. R.p.m. = 160
2 ○ Hydraucone with "C" Cone in Lower Plate. R.p.m. = 160
3 × Hydraucone with "B" Cone in Lower Plate. R.p.m. = 160
4 + Hydraucone with "A" Cone in Lower Plate. R.p.m. = 160
5 □ Straight Tube No. 2 with Hydraucone on Lower End ..... R.p.m. = 160

FIG. 9 CURVES SHOWING RELATION BETWEEN EFFICIENCY AND HORSEPOWER AT 1 FT. HEAD

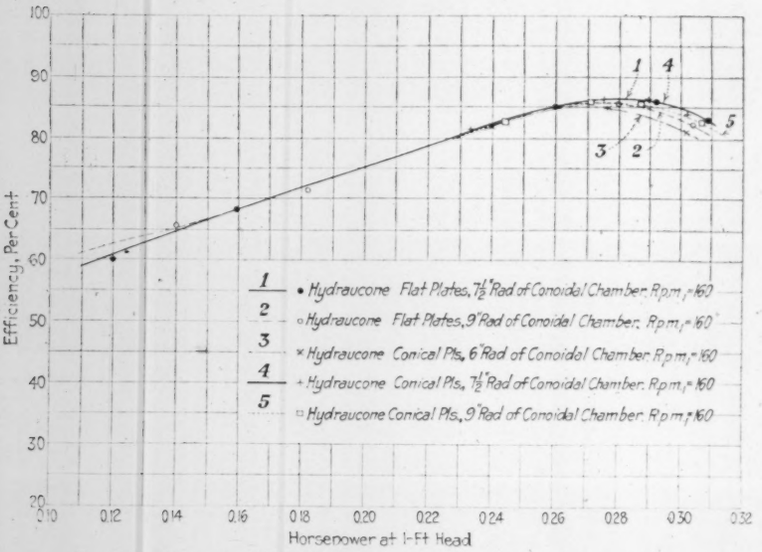
Efficiency, Per Cent
Horsepower at 1-Ft Head
1 • Hydraucone Flat Plates, 7½" Rad of Conoidal Chamber. R.p.m. = 160
2 ○ Hydraucone Flat Plates, 9" Rad of Conoidal Chamber. R.p.m. = 160
3 × Hydraucone Conical Pls., 6" Rad of Conoidal Chamber. R.p.m. = 160
4 + Hydraucone Conical Pls., 7½" Rad of Conoidal Chamber. R.p.m. = 160
5 □ Hydraucone Conical Pls., 9" Rad of Conoidal Chamber. R.p.m. = 160

FIG. 10 CURVES SHOWING RELATION BEWTEEN EFFICIENCY AND HORSEPOWER AT 1 FT. HEAD

Fig. 11, the radius of curvature of the water in making its change in direction is a definite curve and is the minimum which can be used in regaining devices and yet obtain the reactions within the point of impingement which will give smooth stream flow of discharge along the plate and consequently without eddies and attendant losses.

By the term "hydraucone action" of water is meant that action which occurs when an unenclosed stream impinges against and is deflected along a surface. Fig. 11 illustrates the hydraucone action of water when a jet impinges normally upon a flat plate. In considering the three outer stream filaments it was noted and recorded in 1900 that the cross-sectional area of the flow increased in making the turn and decreased at the exit from the turn. By placing a cone on the plate with its axis in line with the center line of the jet the outer shape of the curvature of the water is changed, but not to a great extent because of the low velocities within the center portion of the impinging jet.

When the hydraucone action of the water as illustrated in Fig. 11 was taken into consideration in the laboratory work, conoidal chambers were designed such as the one shown in Fig. 2, and when these were combined with the radial passages the desired results were immediately secured.

TESTS OF SMALLER MODELS

The tests of the various model draft tubes and hydraucone regainers made at the laboratory with the small turbine illustrate the practical, economical and efficient application of the hydraucone principle for increasing the efficiency of water-power developments. Coincident with the series of tests in connection with the small turbine, a series of tests on smaller models were made without the use of a model water wheel. Sometimes these small models were tested before the large models were built and tested with the turbine, and sometimes afterward. These models were all made of such size that the entrance was 4 in. in diameter at the throat as compared with $13\frac{3}{8}$ in. at the throat of the larger models.

The apparatus used for testing the small models is shown in Fig. 12. The model water wheel was removed from the plate-steel cylindrical casing and in its place the curved wooden section L was bolted to the opening at the bottom of the casing. At the bottom of the curved piece L was connected a 4-in. diameter throat T, made of brass pipe with flanges, to the lower end of which the various small models were fastened. Four piezometer openings and as many gages were provided to indicate accurately the pressure at the throat. Gages a, b and c serve to illustrate more or less diagrammatically the method of computing the efficiencies of the small models. The difference in elevation between gages a and c was kept about the same. The reading of the throat gage b varied widely, depending upon the efficiency of the regainer device used. The efficiency of these small models was taken as B divided by A, or in other words, the velocity head regained divided by total velocity head in the water as it passed through the throat T. A small model hydraucone with large-diameter plate is shown attached to the throat in Fig. 12. The model hydraucone was detachable from the flange F of the throat, to which were bolted the various devices tested.

Tests were made with the hydraucone regainers having cones in the center of the chamber, and the distance between the plates was varied. With a tall cone in the center similar to A, Fig. 1, the efficiency obtained was less than 70 per cent. By substituting a low cone similar to that represented by B in the same figure, the

maximum efficiency by varying the distance between the plates was found to be 70 per cent.

One series of tests copied from the record book of a model hydraucone as shown in Fig. 12 having a $2^3/_4$-in. radius of curvature of the conoidal chamber, gave the following efficiencies as the distance between the plates was varied:

Distance between plates, in	$^1/_2$	$^{11}/_{16}$	$^5/_8$	$^{13}/_{16}$	$^{7}/_{8}$	$^{15}/_{16}$	1
Efficiency, per cent	76.7	77	78.5	78.7	78	74	68

By cutting down the diameter of the upper and lower plates to 18 in., using the same radius of curvature of the conoidal chamber, namely, $2^3/_4$ in., and varying the distance between the plates, the following efficiencies were obtained:

Distance between plates, in	$^1/_2$	$^5/_8$	$^3/_4$	$^{11}/_{16}$	$^{13}/_{16}$	$^{7}/_{8}$
Efficiency, per cent	61	65.5	67.5	67	68.8	59.3

Conoidal chambers of various radii of curvature were tested with cone centers, flat plates, and then with depressions or concave surfaces, the latter being developed to secure shorter radius of curvature of the conoidal chamber. The efficiencies obtained with the concave surfaces were about equal to that obtained by the use of the flat plate when the proper curve of the conoidal chamber was used.

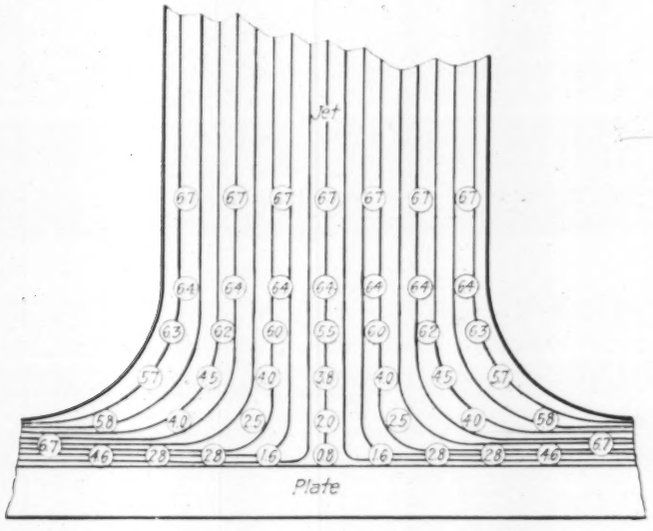

FIG. 11 HYDRAUCONE ACTION OF WATER WHEN A JET IMPINGES NORMALLY ON A FLAT PLATE

Tests were also made upon straight conical and curved draft tubes, and upon square expanding nozzles and elliptical-shaped nozzles as contrasted to the circular straight nozzles. Rectangular and conoidal bends were also tried out.

HOLYOKE TESTS

At the completion of the tests of the various regainers and model draft tubes at the laboratory, a series of tests were made at the Holyoke Testing Flume on a large water wheel having a runner of 30 in. nominal diameter and a discharge diameter of 38 in. The objects of these tests were to verify the results already obtained at the laboratory, and to obtain records of the performance of the hydraucone regainer which could be presented to the engineering profession with the assurance that they were reliable, and could be used for comparison with the results obtained with other forms of draft tubes tested at Holyoke. The water wheel was first tested with a straight draft tube 8 ft. $3^1/_8$ in. in length and with diameters of 3 ft. $3^1/_2$ in. and 6 ft. 3 in. at the smaller and larger ends, respectively. This was the best tube of this type developed by the Allis-Chalmers Manufacturing Company for testing purposes. The results of the tests are shown in Fig. 13, Holyoke test No. 2445, dated Mar. 3, 1916.

The next test was made by placing the water wheel directly on the hydraucone regainer as shown in Fig. 14, and the results are given in Fig. 15, Holyoke test No. 2460, dated May 5, 1916. Fig. 16 gives the results of a test of the water wheel when set on a short straight conical draft tube (3 ft. long), with the discharge of the tube connected with the hydraucone regainer. (Holyoke test No. 2461, dated May 16, 1916.)

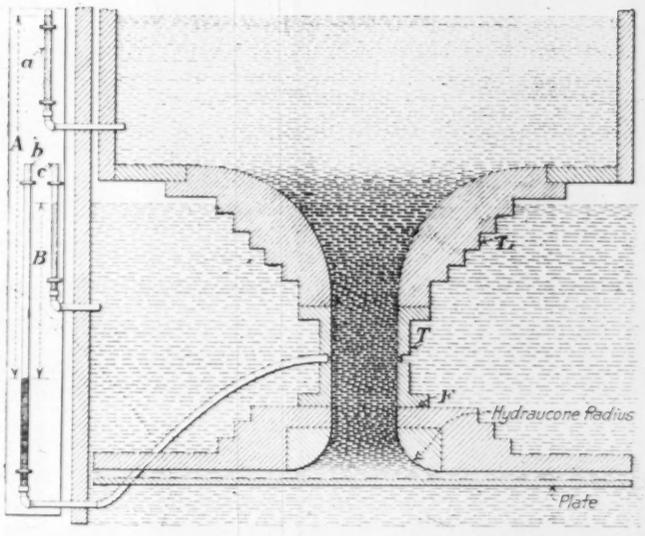

FIG. 12 APPARATUS USED IN TESTING SMALL MODEL DRAFT TUBES AND HYDRAUCONE REGAINERS

Two shapes of conoidal chambers were made and tested; one of which is illustrated in Fig. 14. Tests were made with the plates of the hydraucone regainer set at various distances apart. These tests confirmed those made at the laboratory and showed that the hydraucone regainer could be relied upon for giving high efficiency with commercial water wheels under actual operating conditions. A maximum efficiency of 91.6 per cent was obtained with the use of the hydraucone regainer as shown by Holyoke test No. 2461, which was slightly greater than that obtained with the long straight draft tube in Holyoke test No. 2445. The test

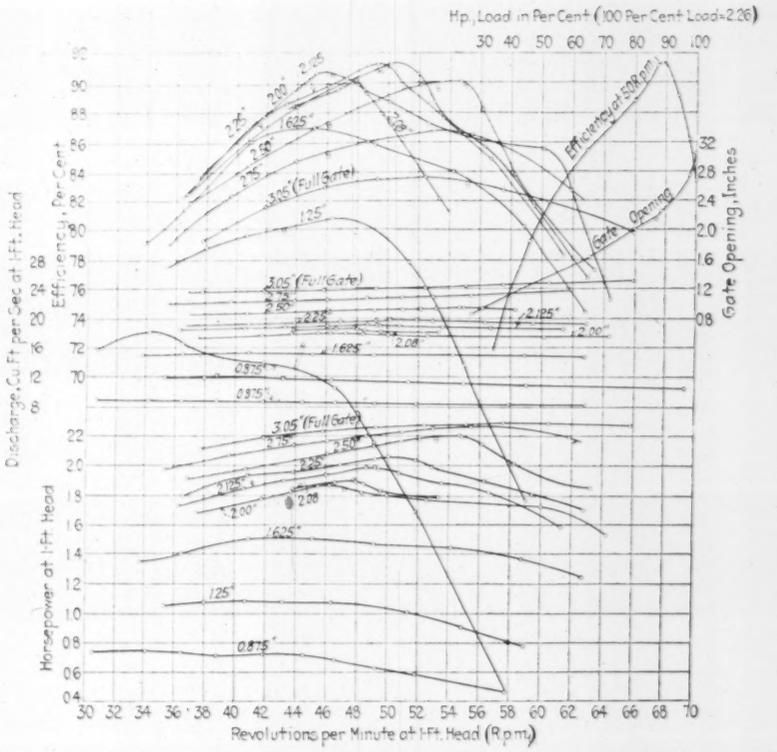

FIG. 13 HOLYOKE TEST NO. 2445 OF 30-IN. RUNNER WITH LONG STRAIGHT CONICAL DRAFT TUBE
(20 guide vanes; guide case $14^1/_1$ in. wide.)

of the water wheel with the hydraucone regainer showed better characteristics at speeds both below and above normal than the test with the straight draft tube, all of which might be expected in view of the radial passages of the hydraucone regainer in which

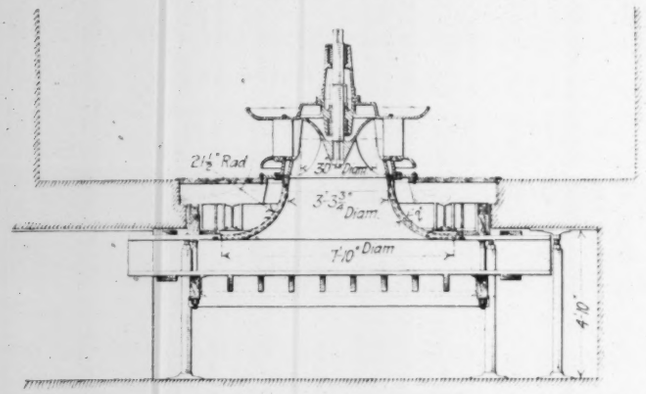

Fig. 14 Water Wheel Placed Directly on Hydraucone Regainer as in Holyoke Test No. 2460

the whirling action of the water is utilized for increasing the efficiency.

Hydraucone regainers with cone centers such as *A*, Fig. 1, were not tested at Holyoke because the laboratory experiments showed conclusively that hydraucone regainers with flat plates gave better efficiency. The friction of the water along the surface of a hard cone center is much greater than the internal friction when the water forms its own cone as shown in Fig. 11. This is one reason why the hydraucone regainer with flat plate gives better efficiency than the hydraucone regainer with cone center.

Results Obtainable by Using Hydraucone Regainers with Runners of Different Specific Speeds

The hydraucone regainer may be employed in any power plant operating under any head with a resulting increase in efficiency. Its actual value in power plants operating under different heads with runners of different specific speed may be seen from Table 1.

Runner No. 1 is a type identical with that used on one of the 37,500-hp. turbines recently put into operation in Station No. 3 Extension of the Niagara Falls Power Company. The specific speed of this runner is about 40 (English system). Runner No. 2 is a reasonably high-speed runner for low-head plants, such as that installed at the Argo Plant of the Eastern Michigan Power Company, and it is the same type as that used in the experiments made at the laboratory. Runner No. 3 is the Allis-Chalmers No. 404 high-speed type furnished to the Cheboygan Electric Light & Power Company, Cheboygan, Mich. This runner was described by Mr. Nagler in his paper presented at the 1919 Annual Meeting of the Society.[1] The axial component of the velocity of the water discharging from each runner is shown in column 6. The energy discharged from the runner in each case is shown to be respectively 4 per cent, 13.7 per cent, 22.4 per cent of the energy of the total head. Draft tubes on high-head plants are usually much more efficient than those on low-head plants. A draft-tube efficiency of 40 per cent may be obtained under ideal conditions in a suitable curved draft tube for use in connection with runner No. 1, but draft tubes on low-head plants are not so efficient, and the efficiency of a curved draft tube such as would be used with runner No. 2 would be about 20 per cent, and with runner No. 3 certainly not exceeding 20 per cent.

[1] A New Type of Hydraulic-Turbine Runner, Forrest Nagler, Trans. Am.Soc.M.E., vol. 41, p. 829.

TABLE 1 INCREASE IN POWER-PLANT EFFICIENCY RESULTING FROM USE OF HYDRAUCONE REGAINER

1	2	3	4	5	6	7	8	9	10	11	12
No. of runner	Specific Speed	Nominal diameter of the runner, in.	Discharge diameter of the runner, in.	Cu. ft. per sec. discharged at 1 ft. head	Vertical component of water discharged from the runner	Energy in discharged water, per cent	Assumed efficiency of draft tube, per cent	Loss of energy with draft tube, per cent	Assumed efficiency of hydraucone regainer, per cent	Loss of energy by hydraucone, per cent	Increase of efficiency by use of hydraucone, per cent
1	40	30	28	1.97	1.65	4	40	2.40	70	1.2	1.2
2	90	30	44.5	32.05	2.97	13.7	20	11	70	4.1	6.9
3	160	30	30	18.5	3.8	22.4	20	17.9	70	6.7	11.2

The efficiency of the hydraucone regainer for use with each of the three runners would be at least 70 per cent. The greater efficiency of the hydraucone regainer over the curved draft tube results in increasing the power-plant efficiency by 1.2 per cent, 6.9 per cent, and 11.2 per cent, respectively, for runners Nos. 1, 2 and 3, as shown by column 12 of Table 1. From this it will be

(Continued on page 419)

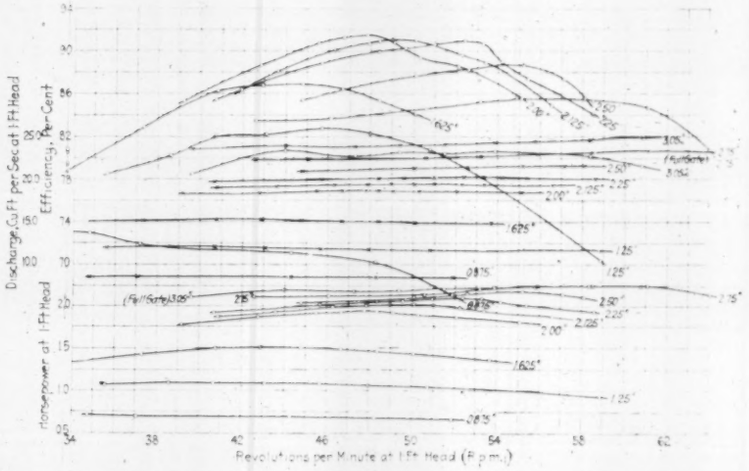

Fig. 15 Holyoke Test No. 2460 of Water Wheel Placed Directly on Hydraucone Regainer

(Radius of conoidal chamber, 21½ in.; distance between plates, 12½ in.)

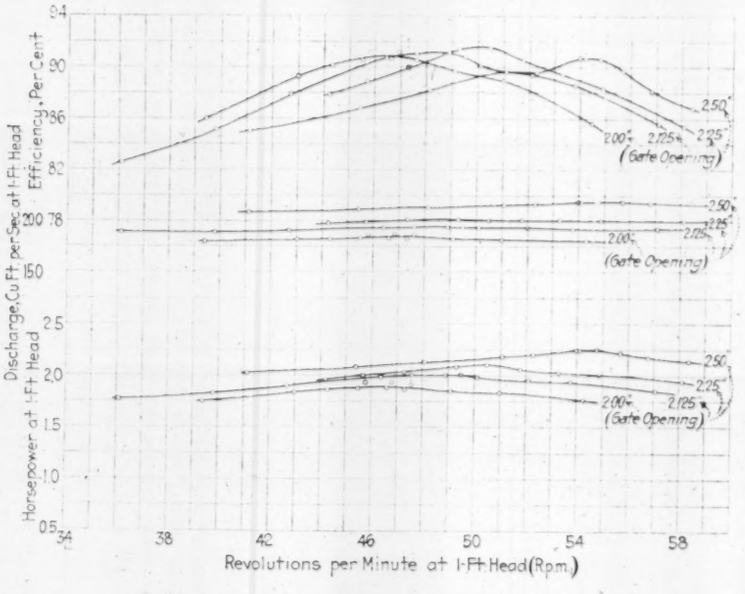

Fig. 16 Holyoke Test No. 2461 of Water Wheel Set on Short Straight Conical Draft Tube and Discharging through a Hydraucone Regainer

(Draft tube of 3 ft. section; radius of conoidal chamber, 25 in.; distance between plates, 12½ in.)

Recording Ash-Pit Loss From Chain-Grate Stokers

By E. G. BAILEY,[1] CLEVELAND, OHIO

This paper presents certain preliminary data obtained from a device recently developed to record the ash-pit loss from chain-grate stokers and thus enable the fireman to effectively control this factor.

The device consists of a thermometer bulb filled with nitrogen and connected through a capillary tube to a recorder consisting of a mercury U-tube, one leg of which is open to the atmosphere and carries a float to which the recorder pen is attached. It has been found that when this bulb is properly located near the rear of a chain-grate stoker, its temperature will respond definitely to changes in the amount of combustible going to the ash pit and will vary in direct proportion to the heat thus lost.

Records of ash-pit loss, excess air, unburned gas, flue-gas temperature and boiler rating make it possible to plot characteristic performance curves for stokers showing the losses due to unburned combustible, unburned gases and excess air, and to determine the proper amount of excess air to be maintained and also the most efficient capacity. These curves can be used to compare relative efficiencies of different types of stokers, the suitability of different kinds of coal, and the effectiveness of the control by the fireman.

THERE has been more guesswork and less knowledge regarding ash-pit loss than any other thing of equal importance in the boiler plant. It pays to watch the ash pile from every kind of stoker or even hand-fired furnaces, though it be only visual inspection to note whether it is well burned out or full of combustible. To sample and analyze the ashes regularly and calculate the heat lost in that manner is better still, yet it is done in comparatively few plants and falls far short of accomplishing the desired result. A sample taken from the entire plant each day leaves the responsibility divided between the different firemen and different types of stokers. To take a sample from each boiler for each shift would still not accomplish as good results as if the ash-pit loss were continuously recorded for each boiler.

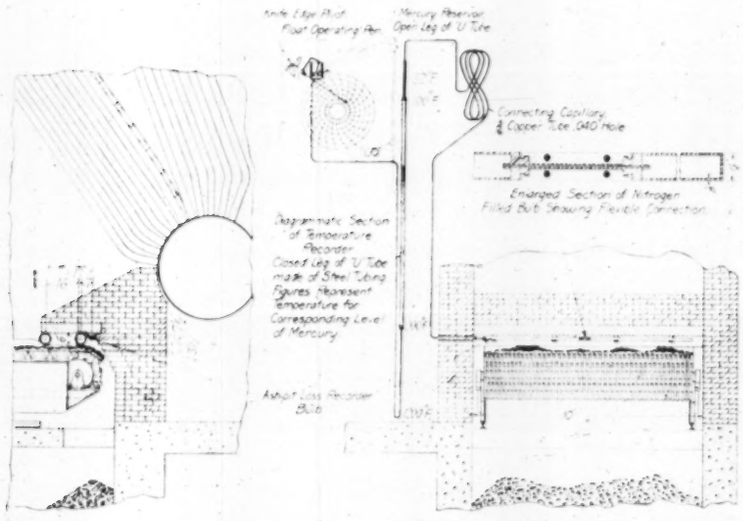

FIG. 1 ASH-PIT LOSS-RECORDER INSTALLATION ON NATURAL-DRAFT CHAIN-GRATE STOKER IN STATION B

Instantaneous readings of any kind are most valuable in aiding the fireman to obtain results. He can then see a faulty condition as soon as it takes place or even starts to take place, and remedy it promptly. If such readings are recorded continuously the fireman can see how quickly the remedy is effective. Such records also show the executive in charge of the plant just what took place at all times.

It is the purpose of this paper to present some preliminary data obtained from a device recently developed to record the ash-pit loss from chain-grate stokers. It may later be extended to some other types of stokers of either the present or modified design, but the great need for it on chain grates led to its being applied to these first.

METHOD OF RECORDING ASH-PIT LOSS

The fundamental principle used in recording the ash-pit lost by this method is to place a temperature-recorder bulb at a point

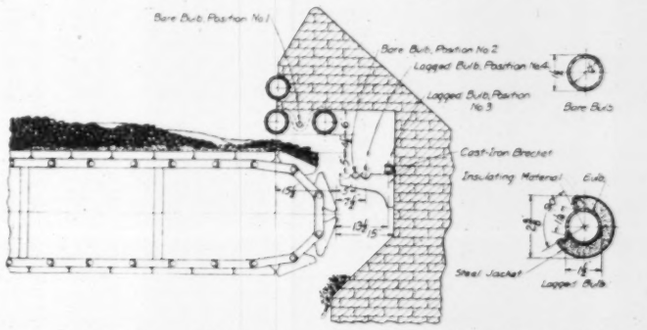

FIG. 2 ASH-PIT LOSS RECORDER ON FORCED-DRAFT CHAIN-GRATE STOKER IN STATION A, SHOWING DIFFERENT BULB CONSTRUCTIONS AND LOCATIONS

near where the ashes are discharged from the active section of the grate or furnace. The bulb is not in contact with the ashes but receives only the radiant heat from the coke being discharged. The relation between this temperature and the amount of combustible in the refuse, and the heat loss due to it, is established by taking a series of samples corresponding to different temperature readings.

If the ashes are well burned out, so that there are no live coals, the temperature is comparatively low. Even though the ash has clinkered rather badly and retained a certain amount of temperature, it has usually lost its glow and is comparatively cold from a radiation standpoint. The coke coming over is still ignited and at a temperature of about 1800 to 2000 deg. fahr., so that its radiant heat to the bulb is sufficient to cause very decided changes in the temperature readings.

In selecting a location for the temperature-recorder bulb, it is necessary to have it shielded from any radiant heat of the furnace itself, and also as free as possible from changes in temperature due to the surrounding brickwork, circulation of air, etc. It is further necessary that the bulb extend across the entire width of the grate and be so constructed as to obtain an accurate average in case the amount of coke coming over is greater on one portion of the grate than an other.

Fig. 1 shows an installation on a natural-draft chain-grate stoker with a 9-ft. bulb located just beyond the water back, which shields it from the heat of the furnace. It is located about seven inches above the rear end of the grate so that the radiant heat from any coke passing under it will increase its temperature.

THE TEMPERATURE RECORDER

The temperature-recorder bulb itself is made very rugged to withstand this service. It is constructed of $1\frac{1}{2}$-in. steel tubing with $\frac{1}{8}$-in. wall and all joints welded. The bulb is charged with

[1] President, Bailey Meter Co., Mem. Am.Soc.M.E.

Abstract of a paper presented at the Spring Meeting, Chicago, May 23 to 26, 1921, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Copies of the complete paper may be obtained on application. All papers are subject to revision.

nitrogen and the gas pressure that is exerted by an increase in temperature is conducted through a $^3/_{16}$-in. copper capillary tube to the recorder. The recorder consists of a simple mercury U-tube, one leg of which is open to the atmosphere and carries a float to which the recorder pen is attached.

The other leg of the U-tube is made up of sections having different cross-sectional areas so that the pen movement is suppressed

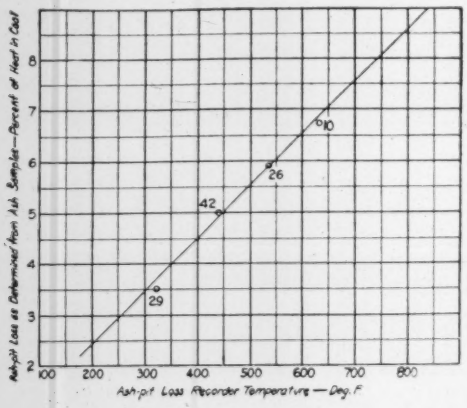

Fig. 3 Ash-Pit Loss and Temperature Relation for Bare Bulb in Position No. 2 (Fig. 2) on Forced-Draft Chain-Grate Stoker as Operated in Station A

(Figures represent number of individual tests averaged.)

below and above the range to be recorded on the chart. It is also possible, if necessary, to have the area of one leg of the U-tube variable so that the percentage of heat loss will be recorded directly with uniform gradations on the chart in case the relationship between the ash-pit loss and temperature should not be a straight line.

The bulb can be made in sections short enough to be installed where the alley between two boilers is narrower than the width of the boiler itself. Each section, however, is welded permanently

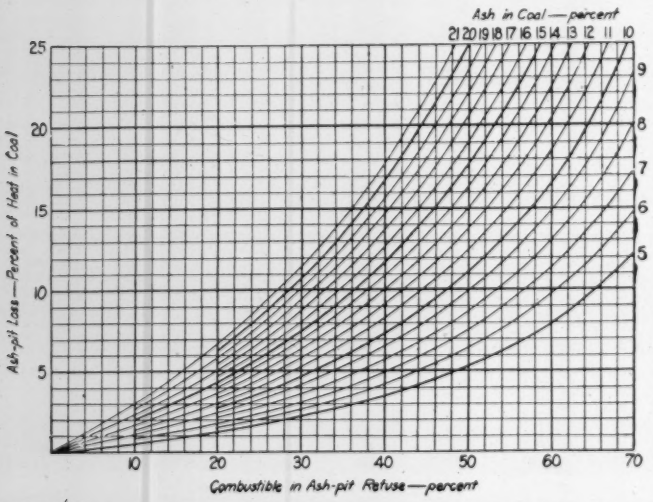

Fig. 4 Relation Between Ash-Pit Loss, Combustible in Refuse and Ash in Coal

with $^1/_4$-in. No. 13 gage steel tube, making a flexible connection so that it can be folded up and then straightened out as it is installed in the furnace.

Up to the present time the experiments have been largely confined to the selection of the best locations for the bulb with respect to the grate and also to determine the relative advantage of bare bulbs and those having lagging around a portion of their circumference so as to minimize the heat received from or given off to the surrounding walls, air, etc.

Fig. 2 shows the location of a bulb at the end of a forced-draft chain-grate stoker. A bare bulb was first located at position No. 1 with cast-iron supports. It was found that when the fuel was up to the bottom of the water back and there was a slight positive pressure in the furnace, a flame would envelop the bulb, sending the temperature up to more than 1500 deg. No data were obtained from this recorder in the No. 1 position.

The bare bulb was next placed on the cast-iron bracket in position No. 2, and after operating several days it was found to be satisfactory as to temperature range and continuous operation. A series of calibration tests was then started to learn what combustible losses corresponded to the different temperature readings.

Relation Between Temperature and Combustible Loss

Samples consisting of *all* the ash discharged from the stoker were taken hourly. The ash as it accumulated in the hopper was quenched immediately by means of a water spray. At the end of the hour the ash was dumped from the hopper, crushed, mixed and quartered by hand until it was reduced to about 20 lb. of 4-mesh size, and sent to the laboratory. The analyses show combustible on the dry basis.

The samples from Station A were collected from time to time between January 20 and March 2, 1921, at times when it was convenient to do the work. Usually five to eight samples were taken each day. In all, 107 samples were taken during 15 different days. About half of them were taken during certain stoker tests that were being made on this boiler and the remainder under everyday operating conditions.

No special effort was made to change operating conditions from normal except in the case of a few samples, when more combustible was run over than usual in order to get some high points to establish the upper part of the curve.

The essential results for the 107 samples taken are plotted in Fig. 3, where each small circle represents the average of all temperature readings grouped between 300 and 400, 400 and 500 deg. fahr., etc. It is noted that the ash-pit loss is about 3.5 per cent at 300 deg. and increases 1 per cent for each 100 deg. temperature rise.

It was first thought best to plot the results between temperature and percentage of combustible in the ashes, but it was found that the ash in the coal varied between 8.5 and 14 per cent. From the curves of Fig. 4 it is noted that with samples having 30 per

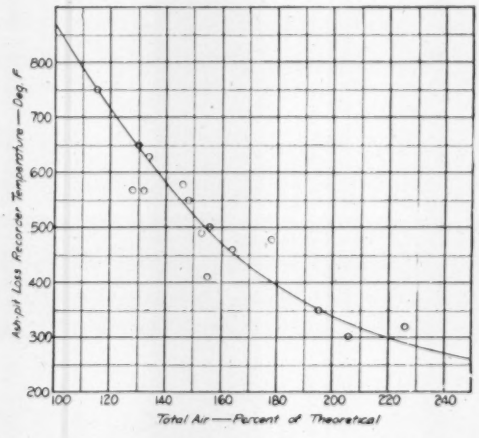

Fig. 5 Relation Between Total Air Used for Combustion and Ash-Pit Loss-Recorder Temperature Obtained from Forced-Draft Chain-Grate Stoker Operated in Station A

cent combustible the heat loss is 3.9 per cent from the 8.5 per cent ash coal and 7 per cent from coal with 14 per cent ash, hence each test was figured on a basis of the heat loss due to unburned carbon, expressed in percentage of the heat in the coal.

The relation between percentage of combustible in refuse, ash in coal, and ash-pit loss is given in the series of curves in Fig. 4. These curves are plotted from the formula:

$$\text{Combustible loss} = \frac{100\,ac}{(100-a)\,(100-c)}$$

where a is the percentage of ash in the coal and c the percentage of combustible in the refuse. This formula is based upon the assumption that all of the ash from the coal goes to the ash pit and

that the heating value per pound of combustible in the ash pit is the same as that of the combustible in the coal.

Emphasis is usually placed upon the percentage of combustible in the ashes as being the true measure of loss due to unburned carbon, but it is of equal importance to know the percentage of ash in the coal. There is more heat lost with 20 per cent combustible in the refuse from a coal with 20 per cent ash than with 40 per cent combustible in the refuse from a coal with 8 per cent ash.

One naturally questions whether the temperature of a bulb at such a location will vary with the percentage of heat lost or with the percentage of combustible in the refuse; whether either relation will hold true for different percentages of ash in the coal, or whether it varies with the boiler rating, grate speed, etc. The final answer to such questions can only be determined from results of actual tests. Fig. 3 is plotted from the 107 samples and it shows conclusively that the temperature varies directly with the percentage of the heat of the coal lost in unburned carbon. Various other plots and studies of the individual tests fail to show any tendency for the results to deviate from this curve due to changes in the percentage of ash in the coal, the grate speed, or the boiler rating.

This is very fortunate, as the temperature record can then be used directly in determining the heat loss without the necessity of bothering with percentage of ash in coal or any other modifying factors. In fact, the chart can be graduated direct in percentage of heat lost instead of temperature. Samples of coal and combustible are needed only for making the calibration tests, which

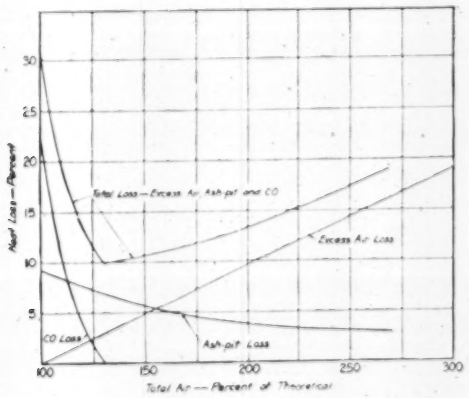

FIG. 6 CHARACTERISTIC LOSS CURVES, ON BASIS OF TOTAL AIR, OF FORCED-DRAFT CHAIN-GRATE STOKER AS OPERATED IN STATION A

should be determined for each type of installation. At least this will be necessary until more data have been obtained regarding location of bulb and the characteristics of different types of stokers, arrangements of water backs, etc., as these are likely to produce a different rate of temperature change as shown later in this paper.

PERFORMANCE RESULTS FROM CHAIN-GRATE STOKERS

It is well known that with a chain-grate stoker the ash-pit loss tends to increase as the excess air is decreased, and vice versa. It is only natural that more coal should be wasted over the end of the grate when the fuel bed is kept thicker and carried to the water back. When the fire burns short a reduction is made in the ash-pit loss, but there is a decided increase in the percentage of excess air. As a matter of fact this is generally true in all types of stokers, and even in hand firing. That is, a reduction in unburned coal usually means some increase in excess air, so that decreasing one loss increases another.

The problem is then to determine what method of operation will give the lowest total loss, and the ash-pit loss recorder makes it possible to plot out these relations as combustion characteristics of the stoker.

RELATION BETWEEN ASH-PIT LOSS AND TOTAL AIR USED FOR COMBUSTION

Fig. 5 shows a very definite relation between temperature as indicated by the ash-pit loss recorder and the total air used for combustion on a basis of the theoretical air being 100 per cent. In plotting the points the total air was taken from the ratio of air flow to steam flow as shown on chart records, using only periods when the steam flow, the air flow and the ash-pit loss-recorder temperature were each very uniform over stretches of two hours or more at one time, indicating that the conditions had settled to normal and were not varying continuously.

The values taken from the average curve of Fig. 5 are used to calculate the heat losses and are plotted in Fig. 6, showing the

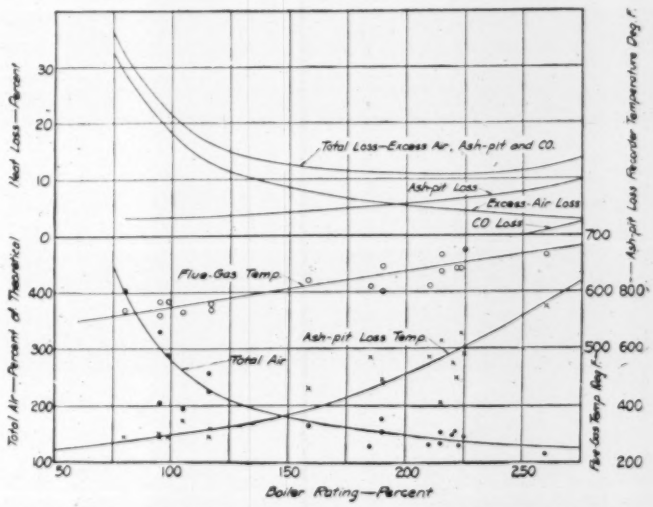

FIG. 7 CHARACTERISTIC LOSS CURVES, ON BASIS OF BOILER RATING, OF FORCED-DRAFT CHAIN-GRATE STOKER AS OPERATED IN STATION A

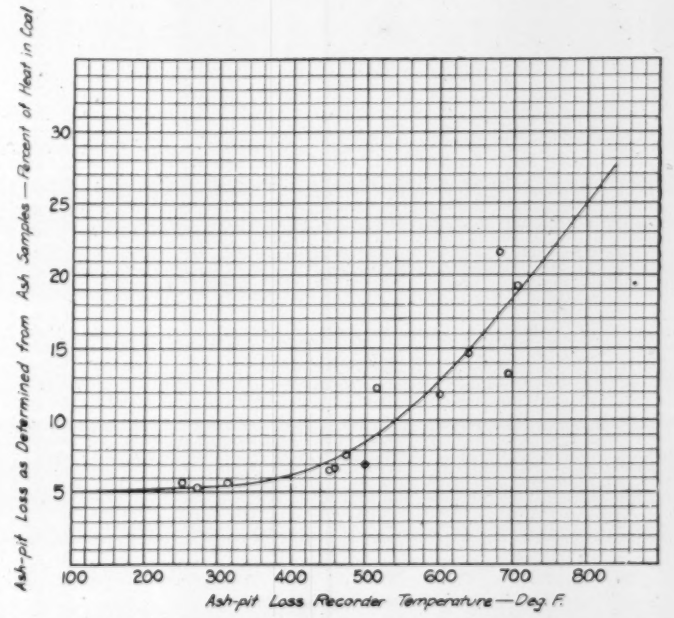

FIG. 8 ASH-PIT LOSS AND TEMPERATURE RELATION, BULB AS IN FIG. 1, ON NATURAL-DRAFT CHAIN-GRATE STOKER, STATION B
(Each point represents an individual one-hour sample.)

characteristic loss curves for a forced-draft chain-grate stoker as operated in Station A. This set of curves shows that percentage of heat lost in excess of air (based on a 500-deg. temperature rise) increases from zero up to 19 per cent at 300 per cent total air. As the excess-air loss is reduced the ash-pit loss increases, but the rate of increase is less than the rate of decrease in the excess-air loss, so the total of these losses decreases until the total air is about 130 per cent. At this point CO and unburned gases appear, and the percentage of heat lost in consequence increases very rapidly as the amount of air is reduced to 100 per cent or the theoretical amount. It is therefore best to operate this stoker at about 130 to 140 per cent total air.

It is quite possible that, with a little better care upon the part of the fireman, the combustible loss could be considerably reduced on this type of stoker, even at this low percentage of excess air. This would then lower the total curves so that the combined loss would be still lower than the 10 per cent shown in Fig. 6 as the minimum point.

Relation Between Capacity and Stoker Losses

Fig. 7 shows the relations between the boiler rating and flue-gas temperature, excess air, unburned combustible, and CO, with the percentage of heat lost in each. The total of these three losses is seen to be at a minimum of 11 per cent at 225 per cent rating and to remain below 12 per cent at all ratings between 160 and 260 per cent.

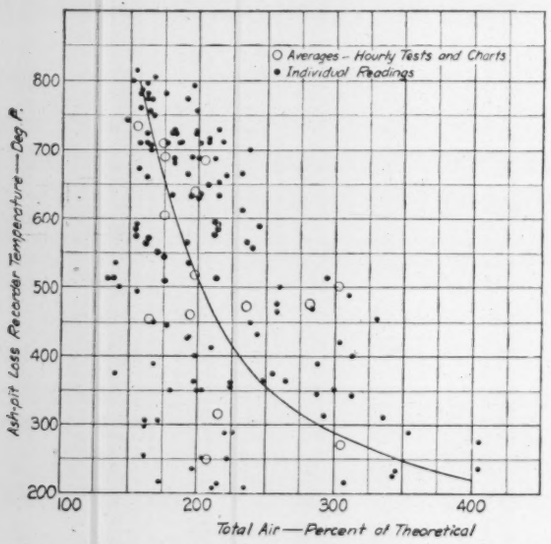

Fig. 9 Relation Between Total Air Used for Combustion and Ash-Pit Loss-Recorder Temperature Obtained from Natural-Draft Chain-Grate Stoker as Operated in Station B

The minimum loss in Fig. 6 is 10 per cent because the excess-air loss is calculated on the arbitrary bases of 500 deg. fahr. rise in flue-gas temperature, while in Fig. 7 it is calculated on the actual temperature, which is as high as 650 deg. at the higher rating.

If it were possible to operate this stoker with lower excess air at the lower ratings and lower ash-pit loss at the higher ratings, the total losses would be materially decreased and the curve would be flatter. In fact, the range of best efficiency as shown in Fig. 6 should be almost entirely independent of boiler rating if the same care is exercised by the fireman at the low ratings as he must exercise at the high ratings to produce the steam.

To obtain the total overall efficiency curves for stoker, furnace, boiler, and perhaps economizer, the other losses due to products of combustion and infiltration of air should be included according to the equipment used. There is also the question of overhead charges and repairs to stokers and brickwork that increase with higher rating or lower excess air.

Characteristic Curves of Stokers

This set of curves raises the question, can true characteristic curves be drawn showing the performance of the stoker itself? Very little has been done in this direction, but such data have been well established for centrifugal pumps, motors, turbines, fans and blowers.

In the operation of a stoker so much depends upon the character and quantity of coal being burned and also upon the human element of the fireman that the true characteristics of the stoker are usually so clouded that they do not appear in their true form.

Most boiler tests give combined efficiency of furnace and boiler as it is difficult to separate the two. In reality it is not necessary to separate these two efficiencies or even to determine the efficiencies at all, because a great deal more can be accomplished through studying the losses than can be obtained from knowing the overall efficiency alone. We know that if the losses are high the efficiency is low, and vice versa. It is also easy to separate certain of the losses and charge them directly to the furnace, while other losses may be chargeable entirely to the boiler and still others are beyond the control of either.

The three important losses existing in boiler and furnace operation that are chargeable directly to the stoker and furnace are unburned combustible in ashes, unburned gas, and excess air. The latter two losses may be influenced somewhat by the size of the furnace and combustion chamber, and the last one by the leakage of air through the boiler setting, but on the whole they depend almost entirely upon the stoker and its operation.

If the characteristics of the stoker are properly determined one can then see the best relation between these factors in order that the total of the three losses be a minimum. We are then assured the furnace efficiency is highest, even though we may not know the exact thermal efficiency of the furnace and stoker itself, separate from the boiler.

In operating stokers it has been considered that the character of the coal and the method of operation were far more important than the characteristics of the stoker itself. This, however, is only an admission that the stoker was not so designed that its characteristics would dominate over the other factors, namely, coal and fireman. Very great improvements have been made in stoker design and methods of operation, but there is need for still further advancement. A careful analysis of the problem by means of continuous graphic records of all the losses and characteristic performance curves like those shown in Figs. 6 and 7 will aid in further improvements in both design and operation as well as in selecting coal for the stoker or the selection of a stoker for the coal available.

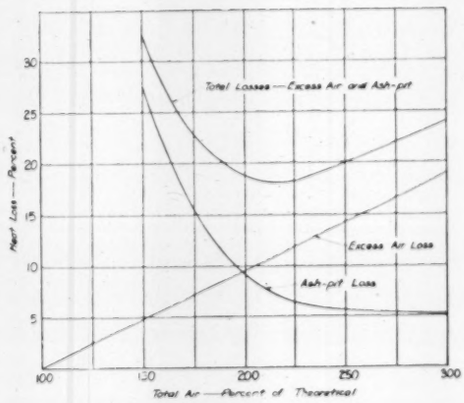

Fig. 10 Characteristic Loss Curves, on Basis of Total Air, of Natural-Draft Chain-Grate Stoker as Operated in Station B

Even where ash-pit loss recorders cannot now be easily applied to some types of stokers it is possible to take hourly samples of the refuse and plot the characteristic combustion and capacity curves like those in Figs. 6 and 7. For stokers with intermittent ash dumps the period for each test should be the same as the period between dumps, maintaining the operating conditions as uniform as possible during this period and taking the ash sample from each dump. As the value of these results does not depend upon coal weights and evaporation efficiencies, short tests are satisfactory for determining the losses due to excess air, unburned gas and unburned coal. All of the losses of the boiler heat balance, except radiation, can be determined almost if not quite as accurately as can be the evaporation.

Results from Natural-Draft Chain-Grate Stoker at Station B

Figs. 8 to 12 give the data from thirteen ash samples and tests on a natural-draft chain-grate stoker equipped with an ash-pit loss recorder as shown in Fig. 1. These data were obtained on three consecutive days from a boiler that was being operated in a stand-by station. The load conditions did not require careful attention to the stoker operation, hence the results should not be taken as indicative of the best performance with this type of

stoker. Neither should these results be used for comparing one type of stoker with another, because the operating factors, namely, coal and fireman, may be very different.

In Fig. 8 the ash-pit loss increases very slowly with the initial rise in temperature and then more rapidly at the higher temperatures. Referring to Fig. 1, it will be seen that the bulb is located at a different position with respect to the fuel bed than in Station A. In this case the bulb is directly over the end of the grate, and looks down upon the coke as it passes beneath it. With a very short fire the coke may "go out" or cease to burn before it reaches the water back and yet contain a considerable percentage of combustible, hence the minimum loss of 5 per cent with little or no radiant heat. As soon as a few pieces of hot coke are carried over, the effect upon the bulb is very marked and a considerable rise in temperature takes place until the grate is covered with coke. A greater amount of combustible will add only to the thickness of the layer and not increase the area of the hot coke within the vision of the bulb in this location. The increase in the temperature of the bulb is due only to the closer proximity of the hot coke to it after the grate is once covered.

In Fig. 9 the relation plotted between total air and ash-pit loss-recorder temperature shows widely scattered points. This is largely because the fuel-bed conditions vary rapidly, and there is considerable time lag between the condition of the fuel bed on the grate proper and the amount of coke being discharged at the same time. The log, Fig. 12, plotted over a short period, shows a typical case of the variations as the fire burns thin and is again thickened. The ash-pit loss-recorder temperature drops with the short fire, but the lowest temperature is not reached until twenty minutes after the greatest air excess and the lowest steam flow.

The conditions of the fuel bed on this stoker are sometimes very good and sometimes very poor, just as it may happen, due either to the stoker characteristics, the human factor, or the coal factor, or to a combination of all three. In any case there are certain average conditions which tend to repeat and show the relationship between the various factors. It is very evident from Fig. 9 that very high excess-air and high ash-pit losses do not occur at the same time, although either may be low when the other is high, but they should both be low for the best efficiency.

In Fig. 10 it will be noted that the natural-draft chain-grate

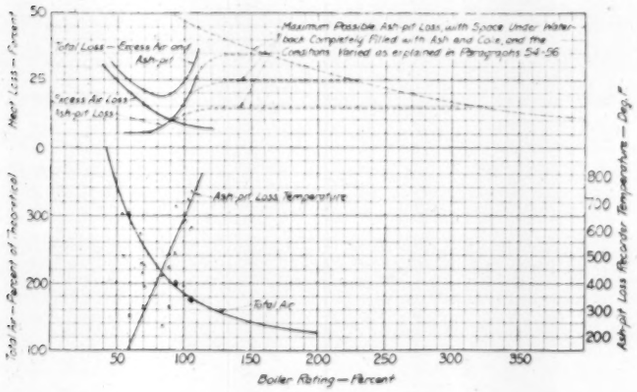
Heat Loss — Percent
Total Loss — Excess Air and Ash-pit
Excess Air Loss
Ash-pit Loss
Maximum Possible Ash-pit Loss with Space Under Water-back Completely Filled with Ash and Coke, and the Constants Varied as explained in Paragraphs 54-56
Total Air — Percent of Theoretical
Ash-pit Loss Temperature
Total Air
Ash-pit Loss Recorder Temperature — Deg. F.
Boiler Rating — Percent

FIG. 11 CHARACTERISTIC LOSS CURVES, ON BASIS OF BOILER RATING, OF NATURAL-DRAFT CHAIN-GRATE STOKER AS OPERATED IN STATION B

stoker in question, as it was being operated at this time, gives the best efficiency at about 210 per cent total air, with a loss of 18 per cent due to excess air and unburned coal. We all know that better results than this can be obtained under suitable load conditions with good operation and the right kind of coal, yet these curves indicate that there is a tendency for the losses to increase very rapidly as the fire changes to a shorter or longer condition from the most economical point.

The air having free and equal access to all parts of the grate takes the path of least resistance through the fuel bed and develops holes very rapidly when once started. In many plants the boilers are operated with the damper wide open. If the maximum amount of steam is not needed the fire burns short. If more steam is needed the stoker is speeded up and a little greater proportion of the grate area is covered with active fuel bed. In other words, the steam pressure is regulated by means of excess air. Fig. 12 shows this very nicely, as the air flow remains practically constant and more or less steam is produced as the coal is fed into the path of the air.

Fig. 11 shows the excess-air and ash-pit losses plotted on a basis of boiler rating. The total of these two losses has its lowest value of 18 per cent at about 90 per cent rating. At lower ratings the excess-air loss increases rapidly and at higher ratings the unburned-coal loss increases even more rapidly.

One naturally wonders whether the ash-pit loss would continue increasing at the rate indicated by the slope of this curve if the boiler were operated at still higher rating. The limit in this direction is reached when the space under the water back is completely filled with ash and coke. The percentage of combustible lost when operating with the space under the water back completely filled with ash and coke combined, will depend upon the percentage of ash in the coal, the coal-gate opening, and the height of the water back above the grate, and will be practically independent of the speed of the grate.

If the increased rate of combustion is obtained by increasing the gate opening and the intensity of draft, leaving the grate speed and the space under the water back constant for a given percentage of ash in the coal, a decrease in the ash-pit loss will result as shown by the upper dotted curve at the right of Fig. 11, because there will then be more ash per square foot of grate and therefore less space left for coke under the water back.

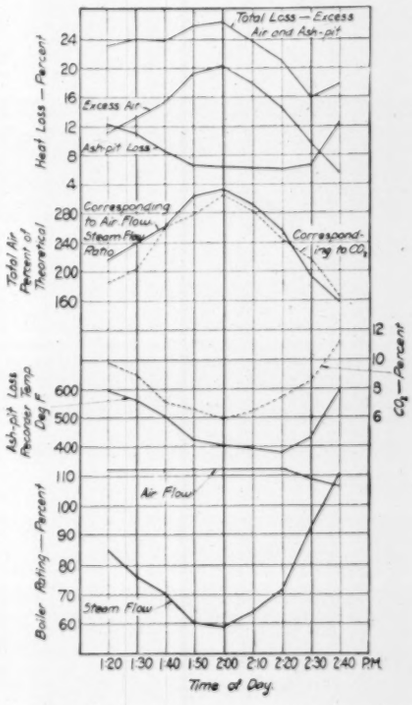
Total Loss — Excess Air and Ash-pit
Heat Loss — Percent
Excess Air
Ash-pit Loss
Total Air Percent of Theoretical
Corresponding to Air Flow Steam Flow Ratio
Corresponding to CO_2
Ash-pit Loss Recorder Temp. Deg. F.
CO_2 — Percent
Air Flow
Boiler Rating — Percent
Steam Flow
1:20 1:30 1:40 1:50 2:00 2:10 2:20 2:30 2:40 P.M.
Time of Day

FIG. 12 LOG SHOWING CHANGE OF FUEL BED ON NATURAL-DRAFT CHAIN-GRATE STOKER AS OPERATED IN STATION B

For any given relation between gate openings and space under water back the percentage of combustible lost would decrease with increased percentages of ash in the coal, and should of course remain constant for different ratings. A change in the height of the water back would also have a similar effect, the percentage of ash-pit loss remaining the same for all ratings in both cases so long as the space under the water back was kept completely filled and increased ratings obtained by increasing grate speed.

If the fire burns thinner, the ash-pit loss will be decreased for any of the foregoing conditions and the excess-air loss increased.

It is believed that characteristic curves like those shown in Figs. 10 and 11 will be very helpful in obtaining the best results from natural-draft chain-grate stokers. By means of such curves we should be able to accomplish better results in the arrangement of water backs, regulation of coal gate, grate speed, draft, etc., and also assist the fireman in obtaining the required amount of steam with the minimum loss.

Road Building and the Mechanical Engineer

Their Problems in Relation to Road-Building Machinery Presented Under the Auspices of the Materials Handling Division at the A.S.M.E. Spring Meeting

THE avenues of transportation of most importance to the greatest body of the public are the highways of the country. During the last five years highway construction has passed through a period of stress, which has focused attention on the proper application of machinery to the building of highways. The Materials Handling Division of the A.S.M.E. in devoting its Spring Meeting session to this subject afforded an opportunity for the contractor to meet with the engineer to discuss all phases of the problem.

While the extensive use of mechanical equipment may be of help to the road contractor, there is the added problem of increased overhead with the necessity for continuity in the operation of expensive equipment, calling for a complete understanding of the contractor's needs by the mechanical engineer.

The papers presented at the Chicago meeting emphasize to the contractor the importanc e of a careful planning of road-construction operations to better utilize mechanical equipment. There are no statements of principles by which the road contractor may be guided in the choice of equipment for a particular job and the presentations were made in the hope that their discussion would lead to the enunciation of such principles.

The meeting was also arranged with the idea of making clear to the mechanical engineer his field in the improvement of design of mechanical equipment for road-building purposes. The standardization of various types of apparatus is stressed in the papers and the importance of the publication of engineering data in regard to these various types is strongly recommended.

Road-Construction Plants

By B. H. PIEPMEIER,[1] SPRINGFIELD, ILL.

SUCCESSFUL road work offers more possibilities for different types of plants than perhaps any other single line of building construction, and every section of road to be built is a field for intensive study and investigation by the engineer and contractor. A thorough examination of the road plants in operation for the past few years shows clearly the need of more careful study of plant problems than is ordinarily given by engineer or contractor.

A successful road contractor in Illinois states: "No equipment should be purchased by a contractor unless he has sufficient work in view to enable him to practically pay for the equipment with a reasonable profit." If this rule were followed by more contractors, on many jobs, there would undoubtedly be less equipment and more profit. Such a statement should in no way discourage the road contractor in equipping himself thoroughly to do economical road work, but should force him to make a more complete analysis of his job before he invests in a road-building plant.

Small Construction Unit Advantageous—Duplicate Units Desirable

In general, the building of a system of roads requires the installation of a number of small plants in preference to a few large plants. This has been particularly true in the past on account of (1) the contractor's inability to secure experienced and capable superintendents for handling large-plant operations; (2) railroad transportation falling short in the delivery of sufficient materials to keep large plants working efficiently; and (3) frequent breaking of the machinery required in large road-construction plants—the breakdown of one machine very often delaying the entire plant operations and causing undue expense.

The small construction unit necessitates doing many operations by hand at somewhat greater expense than if done with machinery; however, when the final analysis is made, the small unit will show considerable efficiency on account of the possibility of its operating many times independently of any one particular machine out of service through breakdown.

Conditions existing during the past few years have made it impossible for the contractor with a large plant layout to show a fair profit. As soon as labor and transportation conditions become more stabilized, the large plant will show a much greater efficiency.

Contractors must give considerably more thought to the design of road plant so that its successful operation may not be wholly dependent upon one piece of machinery. Many successful road contractors realize already that to insure a constant and uniform output, it is economy in many instances to duplicate machines. Some contractors have installed a duplicate pumping system for the water supply, which is vital to the successful and economical operation of the road plant, and the additional cost of the duplicate unit is small compared to the advantage of being able to operate the plant without a delay.

In many instances duplicating concrete mixers has prevented a complete shutdown of operations. The average road job may not always justify a duplication of the mechanical units, but where a large season's work is required, a serious investigation of the advantage of the duplicate units should be made.

Transportation of Materials

The transportation problem in road building is one of the most important factors in the economical construction of roads. Consequently this part of the plant operation should be given a great deal of study. The transportation cost, should not only be estimated on the basis of the ton-mile cost but the effect it may have on the cost of operation of the remainder of the construction plant should be taken into consideration. Hauling cost varies from 20 to 40 cents per ton-mile. In a season's work a saving, therefore, of but a few cents per ton-mile may amount to several thousand dollars. The actual hauling costs may be exceedingly low, yet if the delivery affects the maximum output of the remainder of the plant, the inefficiency should naturally be charged against transportation cost.

Inasmuch as most specifications now prohibit storing road materials upon the subgrade, the road contractor is compelled to provide for transportation in one of two ways. He must deliver materials from his material yard to the road by industrial-railroad equipment or by truck. The industrial equipment, while expensive in first cost, will enable the contractor to complete his work with a minimum amount of trouble under normal conditions and regardless of weather, the average industrial equipment will insure a more uniform delivery of materials than any other unit that may be used. The chief objection to the industrial unit is that it is limited to road construction with grades ordinarily less than 4 per cent and a minimum number of railroad crossings. Further objection would be that the high initial cost demands a large mileage of roads be built each year in order to absorb the interest on the investment and the depreciation.

The other method of delivery is by truck or team. In recent years truck delivery has superseded team delivery, being more rapid and delivering material to a paving mixer or from a mixer direct to the road with less disturbance to the roadbed. Truck transportation of road materials is very flexible and therefore suited to more different sections of work than perhaps any other method of transportation. It is especially suited to the delivery of mixed concrete from a central plant to the road being improved, and to the delivery of proportioned batches direct to the paving mixer or to a

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[1] Engineer of Construction, State of Illinois, Division of Highways.

A group of papers presented at the Spring Meeting, Chicago, May 23 to 26, 1921, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. All papers are subject to revision.

point at which the batch boxes may be transferred to a short industrial line which in turn delivers them to the paving mixer.

DELIVERY OF CONCRETE FROM CENTRAL MIXING PLANT

During the past few years the delivery of mixed concrete from a central mixing plant direct to the job has been attracting considerable attention. This method is worthy of study as it enables the contractor to centralize operations and in many instances to economize in plant and operating expenses. The central mixing plant should be reasonably uniform in design and simple in operation. A study of the central mixing plants in use during the past two years shows no two very similar in design. It would seem possible that unloading aggregate and cement from railroad cars, mixing the materials to the desired proportions and consistency and turning out a mixed concrete, could be standardized to such an extent that central plants could be simplified and made more economical in operation. It is hoped that the mechanical engineer and the equipment designer will assist in the design of a practical and economical central-mixing-plant unit.

Although central mixing plants may be fairly uniform in design, the delivery of the concrete from the plant to the road will vary considerably to suit the existing local conditions. Mixed concrete may be delivered by industrial equipment, provided the hauls are

FIG. 1 MATERIAL YARD, SHOWING ARRANGMENT OF LOADING BINS AND STORAGE PILE

FIG. 2 MATERIAL YARD, SHOWING ARRANGEMENT OF LOADING BINS AND STORAGE PILES WHEN STIFF-LEG DERRICKS ARE USED

reasonably short and the equipment is designed for small loads with considerable speed in transportation. The small pneumatic-tired truck will usually prove the most efficient machine for delivery of mixed concrete, taking the individual batch of mixed concrete direct from the mixer to the road being improved in the least possible time.

USE OF THE PNEUMATIC-TIRED TRUCK

The pneumatic-tired truck is essential when speed is an important factor in delivery and where it is necessary to do considerable hauling over the subgrade. This truck will usually reduce the load on the subgrade to less than 125 lb. per sq. in. of surface, and this pressure, even though frequently applied, does not seriously injure or displace a prepared subgrade having average conditions.

It is true that it is practically impossible to deliver materials over earth roads with trucks when the roads are muddy or during rainy periods. However, the road may be materially improved and the truck used practically the entire construction season if the road is constantly maintained by the use of the road drag and given an application of half a gallon of oil per square yard of surface early in the construction season.

The light pneumatic-tired truck may also be used for the de-

FIG. 3 FOUR-BAG BATCH OF MATERIALS DELIVERED AND DUMPED DIRECTLY INTO SKIP OF MIXER

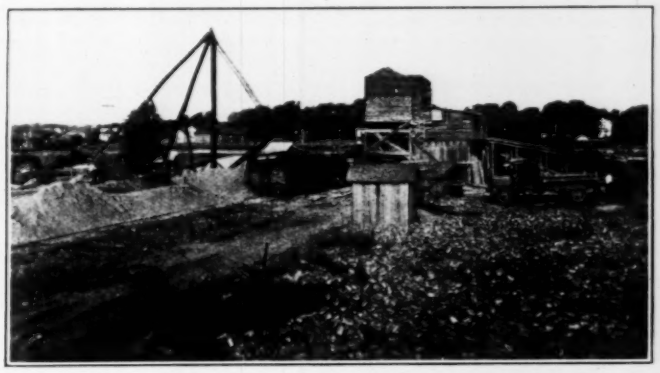

FIG. 4 THREE-TON TRUCKS USED FOR DELIVERY OF MIXED CONCRETE FROM CENTRAL MIXING PLANT

livery of proportioned batches of aggregates direct to the paving mixer on the road being improved. There are now on the market many types of batch boxes and dump bodies which permit the batches to be dumped directly into the skip of the paving mixer. This method has proved to be very satisfactory. It differs from the delivery of mixed concrete in that a paving mixer is used instead of a stationery building mixer, and most of the operations of the contractor are out where the road is actually being laid.

IMPROVEMENTS IN DESIGN OF EQUIPMENT DESIRABLE

The plant investment of the road contractor of today is entirely too expensive compared with the work accomplished during a single construction season or from one particular installation of a construction plant. From $60,000 to $100,000 worth of plant equipment is frequently set up to build less than ten miles of highway. This is equivalent to charging off $2500 to $3000 for equipment against every mile of road built. It is doubtful whether there is any other building construction in which so much depreciation and interest on plant investment must be charged off on so small an amount of work. The mechanical engineer, equipment designer and contractor should apparently spend more time in the design of road-construction plants in order to insure a greater output with less initial investment.

Many of our road-building machines are being made larger, more cumbersome, and more expensive each year. The fact that road-building machinery is subjected to more severe use than perhaps any other machinery used in building construction has induced the manufacturer to add to his equipment each year to insure

more rigid construction. Many machines, such as the concrete paving mixer, can undoubtedly be completely redesigned and a machine produced much smaller in size, to mix more concrete and be less cumbersome on the job.

Mixer manufacturers have continued to improve the design of their paving mixers by following the same principles of mixing that have been in use for many years. It seems absurd that we must have a concrete paver costing from $8,000 to $12,000 and weighing from 10 to 15 tons that will lay less than two miles of 18-ft. concrete road in thirty days. It seems absurd also that we should still be using mixers that require 60 seconds of time for the mixing of aggregate and cement when it should be possible to do the same amount of mixing by some mechanical means in less than 15 seconds. If such a machine could be produced, a one-bag paver would turn out as much concrete as our present four-bag pavers. The present paver is also designed so that the mixing is concealed from the view of the mixer operator. This prevents absolutely the uniform consistency essential in securing a good concrete.

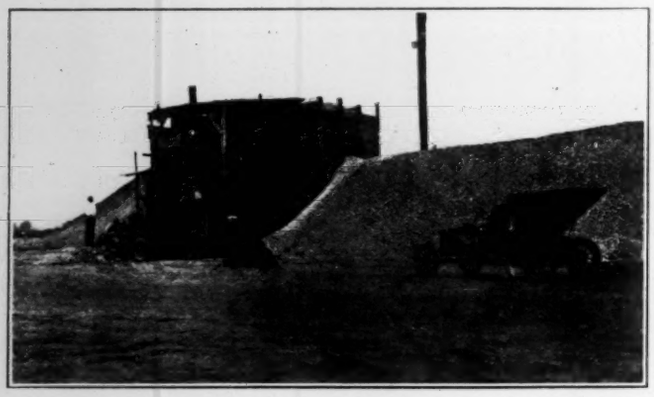

Fig. 5 Central Mixing Plant, Showing Material Storage

If the mixer designer can produce a smaller machine having a greater output per hour of operation and so designed that the consistency of the concrete produced can be controlled by the operator instead of by some unsatisfactory mechanical means, the results will be a wonderful aid to the road-building industry.

Also Room for Improvement in Railroad Equipment

It also seems possible that a very material improvement can be made in the present railroad transportation equipment. Practically all road contractors now unload aggregates from open-top cars by means of clam shells. This method is not always the most economical, but the contractor is forced to use it as he cannot secure all hopper-bottom cars he might desire. On account of the large volume of road materials to be delivered by railroad cars, some type of car should be designed that would permit of more rapid unloading by more economical methods. If this is not done, it is hoped at least that open-top-car manufacturers will improve the design of their cars and make them so that they can be more easily unloaded with clam-shell equipment. Not only would such improvement aid the individual unloading the car, but the railroad company would add to the life of its equipment.

Many open-top cars are now designed with projecting angles, rivets, bolts, braces, timbers, etc., which interfere with the efficient operation of the clam shell. It is difficult to understand why railroad cars could not be designed so that the interior of the car would be perfectly smooth. In fact, it would be practicable and economical for all open-top cars to be built with a fillet having a radius of about 18 in. in the bottom angle at the ends of the car. The curved bottom angles would permit the cars to be emptied more rapidly and economically either with hand shovels or clam shells.

Further investigation should also be made of the use of open-top removable batch boxes for railroad transportation of materials. While the substitution of standardized batch boxes for open-top cars would be a very radical departure from present equipment, the average construction plant could be designed to handle the boxes much more economically than the loose materials.

Mechanical Needs in Highway-Construction Machinery

By R. C. MARSHALL, JR.,[1] Washington, D. C.

THE interest of the mechanical engineer in highway construction centers in the equipment used. This equipment has made great strides in recent years and will undoubtedly continue to do so, yet the equipment needs for road building might be called comparatively simple. Consider a concrete road. All the average road builder needs is a light, portable plant capable of handling, mixing and finishing 400 cu. yd. of concrete every day, with no delay for repairs.

The charge has been made that modern road-building methods have so increased overhead expense that they have accomplished little saving. This may be an exaggeration, but the elaborate equipment now used has undoubtedly increased the overhead to such a degree that steady output of the plant is essential to financial success.

In order that this overhead expense may be kept within reason and highway costs estimated with profitable accuracy, it is essential that contractors have equipment capable of maintaining a steady flow of materials; first, from unloading point to mixer, and second, from there to the finished road. This is the problem confronting the field force and one which must find solution if road building is to become financially safe. Until further development of equipment can assure more continuous performance, construction companies must insure themselves against the loss caused by frequent delays.

The slogan of the designer should be, "Make the machine fool-proof." Increased strength may demand heavier parts and increased first cost, but this is inconsiderable compared with the loss due to one breakdown.

Last year's work, on account of spasmodic and continued delay, was not conducive to a careful study of equipment needs. Transportation troubles so disrupted operations that contractors were obliged to grasp at any expedient to push their work. This, combined with labor and material scarcity, left them little time for a constructive study of their specific equipment needs. Of one thing, however, nearly every road builder is keenly aware. His work suffered heavily from frequent interruptions which disorganized his force and increased the unit overhead cost. Delays from transportation difficulties and equipment trouble caused the overhead expense to absorb a large portion of his profit and in some cases much of his capital. Delays caused by equipment trouble are traceable to three main causes: First, lack of skilful mechanics; second, lack of standardization in design, and third, lack of accurate information concerning the adaptability, capacity and operation of machines.

The lack of skilful mechanics concerns both manufacturers and contractors. An equipment company may expend much time and money in perfecting designs or improving the quality of the workmanship, but if its machines are placed in the hands of incompetent operators, the money spent for them is wasted. Incompetent operators can readily offset the advantages of efficient equipment and well-planned work. Under careless handling the heavy delays for repairs mean a loss of money to the road builder and to the manufacturer a loss of that valuable asset, good will.

An economical solution of the shortage of good operators might be effected by establishing for them a short course of instruction during winter months when construction is slack. Savings effected in the field by competent operators would amount to many times the cost of their instruction. One of the worst obstacles to continuous output would thus be removed.

Plenty of Opportunity for Standardization

The second significant source of delay is a lack of standardization in equipment where standardization is possible. Road-building

[1] General Manager, The Associated General Contractors of America.

plants are generally made up of machines from half a dozen different manufacturers, and to be prepared even for the usual run of minor field repairs on all machines requires a more or less elaborate machine shop. The financial burden of carrying duplicate units or a sufficient number of spare parts is too great for an already heavy overhead, and in order that this expense may be held within reason, greater interchangeability of parts should be made possible.

The amount of saving that might be effected through standardization of road equipment is not generally appreciated. To build a medium-sized high-type section requires a daily field payroll of three or four hundred dollars and an overhead of probably another hundred. So that five hundred dollars per day is not an unusual cost. An employee cannot be laid off every time a breakdown occurs, and since the overhead goes steadily on, fifty dollars an hour may be considered an estimate of the cost of equipment delays.

The third pressing need of road builders, and the one which probably results more frequently in disaster, is a lack of unbiased and authoritative information concerning the adaptability, capacity and operation of machines. Lack of such information has already brought disaster to numerous individual companies, both old and young; and as new concerns are constantly taking up road work, it is essential that they secure authoritative mechanical advice.

What contractors need is accurate data showing under what conditions a certain type of machine is suitable, how long it may reasonably be expected to last, and what output it can deliver under normal working conditions. If this information can be made available, construction companies may be relied upon to intelligently select machines. They will then be able to coördinate their plant and estimate their costs.

Planning and Organizing a Road Job for Mechanical Handling of Material

By C. D. CURTIS,[1] WASHINGTON, D. C.

THE last few years of the decade just closed ushered in a new era in road building. Legislative action stimulated in a large measure by the Federal Aid Road Act has been taken in practically every state, making possible the inauguration of an unprecedented country-wide program of highway improvement. The rapid expansion of the use of the motor vehicle has created an insistent and growing demand for more and better highways. It so happens that this movement has had its greatest growth during a period of rising costs, the crest of which has only recently been passed; so that, along with the urge for more and better highways, there has been always in the mind of the highway engineer the necessity for rigid economy of labor and effort. Fortunately, the inventive genius of the country has not been idle during this period and many new and improved types of road machinery and equipment have been put on the market. The introduction of this new equipment has made it possible to perform mechanically many of the operations connected with road building not only cheaper but better than they can be done by the older hand methods.

While every one will concede that all construction jobs should be carefully planned and well organized for the handling of materials, it must be admitted that this is not always done. In the past too little thought and study have been given to this preliminary phase of the work. Until recently, however, road work has been handled on a comparatively small scale, and the cheaper types of construction prevailed. An extensive plant was not required and the evolution brought about by the general adoption of higher types of construction and the growth of construction programs is still under way. It is unfortunate, but nevertheless a fact, that most jobs are equipped without giving to their planning and organization a proper amount of careful study. As a result expected profits shrink and may even become actual losses. Improperly equipped jobs can be classified under three heads:

1 Too much plant,
2 Lack of plant, and
3 Unbalanced plant.

With too much plant on a job the efficiency of operation is lowered, and although fairly satisfactory progress may be made, the cost will be too high. Rental or interest on investment and depreciation charges continue regardless of output. On an underequipped job it is necessary to resort to labor which may be less efficient and more expensive. The progress of the work is likely to be delayed and total costs increased.

Of all the improperly equipped jobs the ones that have an unbalanced plant are probably most common. They are the inevitable result of equipping without planning. The several units making up the plant may be efficient mechanically when considered alone, but totally incapable of being worked smoothly and continuously together. On such jobs efficient operation cannot be secured. The plant investment might, and probably would, be higher than for a balanced plant. The season's profits, however are certain to be lower than anticipated.

Classification of Road-Building Work Based on Desirable and Practicable Rate of Progress

In the author's opinion a classification of road-construction jobs based on the desirable and practicable rate of progress is feasible and would aid the contractor or engineer in selecting the proper plant. In determining on such a classification several factors would enter into the consideration, chief of which would be the size or length of the project. Another factor would be the problem of satisfactory detours and the probable economic loss to traffic. The cost, of course, would be affected by the classification. Ordinarily a higher rate of progress would be required on a large job than on a small one. The extra cost, then, of assembling and operating a large plant capable of rapid progress would be spread over a large yardage. It might easily happen, however, that the economic conditions would warrant requiring very rapid progress on a comparatively small job. This would change the classification and increase the cost of the work, but the bidder would know just what to expect.

In connection with concrete-road jobs there might be three classes, such as:

A—Jobs on which equipment with a daily capacity of 1000 ft. of 18-ft. roadway would be required;
B—Jobs on which equipment with a daily capacity of 500 ft. of 18-ft. roadway would be required, and
C—Jobs on which equipment with a daily capacity of 250 ft. of 18-ft. roadway would be required.

In the case of Class A jobs it would ordinarily be desirable to equip with at least two complete operating units. This would insure continued, even though retarded, progress in the event of a breakdown of one unit.

Such operations would, of course, be contingent on the weather and other conditions beyond the contractor's control, but the classification would give a more definite idea of the requirements and enable the engineer and all bidders to estimate on exactly the same basis. The classification conditions should be covered in the specifications.

Necessary Limitations Imposed by Specifications

Unnecessary refinements in the specifications which are met with at times usually lead to difficulties in operation and should, in the author's opinion, be avoided, especially where enforcement increases the cost of operation for minor or questionable benefits. There are, however, certain limitations which make necessary an intimate knowledge of the specifications under which work is to be performed. Examples of these limitations are:

1 Time limit on depositing of concrete after mixing. This limit would have a direct bearing on the location of central mixing

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plants and the equipment required for handling both the aggregate and the concrete.

2 Definite requirements relative to concrete mixers such as water-measuring devices, boom and bottom-dumping bucket, etc. Such requirements are small details, but must be met and so must be considered in selecting equipment.

3 Materials for concrete not allowed on subgrade. This feature is very important and makes necessary a careful study of the project in the field. Several alternative methods of handling the materials may be possible, and the most economical and efficient one can only be determined after a consideration of all the conditions. One location might be well adapted to the use of industrial-railway equipment, while in another location this method might be entirely impracticable and hauling of proportioned batches of aggregate and cement in trucks the most feasible. The central-mixing-plant method might be the proper selection in some other location. In the case of a large job conditions may vary considerably on different sections of the same job.

PRECAUTIONS TO BE TAKEN IN SELECTING EQUIPMENT

In selecting equipment for a project, everything bearing on the situation should be considered. The source of materials to be used, whether local or imported, condition of roads to hauled over, width of available right of way, trackage and storage facilities available at receiving points for materials requiring rail transportation, maximum grades, water supply, availability of common labor and teams, and length of working season are some of the factors which should be looked into and studied before deciding on the type of plant to be used. In this connection the engineer may and should render all possible aid to the contractors. The preliminary investigations and detailed surveys made by the engineer give him much more information than the contractor can secure readily in his preliminary field inspection of the project. If the engineer knows that the conditions, even though not apparent, make the use of certain types of material impracticable, this information should be given to the contractor.

A feature which perhaps is not germane to this discussion but which is very important and deserves a few words, is the desirability of considering the source of the materials to be used with respect to the possibility of continuous rail-transportation service. Without a reasonable assurance of a continuous supply of materials throughout the working season, an elaborate plant layout may become much more of a liability than an asset. By arranging to ship and store materials during the season of light demand for open-top cars, for use during periods of car shortage, a continuous supply of materials can be secured. Such an arrangement may considerably alter the selection of equipment for handling the material. Strong arguments may be made against the plan of advance storage of materials in states where estimates for materials delivered are not allowed, but the extra cost of storing materials may be more than offset by the gain due to continuous operation during the construction season.

It is desirable, of course, when possible, to avoid all unnecessary rehandling of materials. Where the materials can be unloaded from cars or loaded from the quarry or pit directly into containers for transportation to the job and in addition can be deposited in the mixer, in the case of concrete, without touching the ground, a great advantage is gained. In addition to being kept clean and free from mixture with foreign matter, the item of waste is very greatly reduced.

EXCLUSIVE DEVELOPMENT OF LARGE INDIVIDUAL UNITS UNDESIRABLE

In some states, by adopting the practice of letting large contracts for long stretches of construction work, large contracting companies have been induced to enter the highway field. They have brought trained operating organizations to the work and have put extensive road-building plants on their jobs. There is wisdom in such procedure whenever possible, for, of necessity, a great many road jobs are and will continue, for a variety of reasons, to be of comparatively short length. Letting contracts in both large and small sections gives both the small contractor and the large a field of operation and greatly expedites the carrying forward of a large program. The small contractor, acting as his own superintendent and operating with but little mechanical equipment, has but little overhead and can compete on a small job with the large contractor operating a large plant and carrying heavy overhead expenses.

Road building differs from most other construction activities in that the operations are conducted along an extended narrow path. The failure of one link may interrupt the work of a whole operating chain. This fact, in the author's opinion, makes the present tendency toward the development of large individual units somewhat questionable. When a large unit is used every precaution should be taken to insure its continuous operation.

IMPORTANCE OF MAINTAINING ORGANIZATION THE YEAR AROUND

One of the greatest handicaps which the road builder encounters in the northern states is the short construction season. Continuous operation is impossible and each season it is necessary to organize new construction forces. It takes some little time to organize a new outfit so that the work will proceed satisfactorily. In the case of the skilled mechanics and foremen, an attempt should be made to retain their service the year around. They can be utilized during the winter in repairing equipment and putting it in first-class condition for the next season's work. It may even be necessary to furlough them for a time with pay, but the investment will bring big returns in added loyalty to the company and increased devotion to duty. The average man appreciates a square deal and will show it in increased efficiency. The use of an extensive plant requires skilled operators, and, once trained, their services should be retained. Efficiency of operation in road work depends on the proper functioning of all the separate units. The mechanical units function properly only when properly handled.

On large jobs where more than one plant or complete operating unit is used, the spirit of the organization can be kept up by introducing friendly competition. The rivalry between two outfits to reduce costs and increase yardage has a very healthful effect on progress and incidentally on profits. The author recalls a bituminous-concrete construction project on which four separate mixing plants were used. One of the plants was an old, makeshift affair, but was handled by an energetic suprintendent who had old and loyal employees of the company as foremen and mechanics. The output and costs compared more than favorably with the new plants, due entirely to the better morale of the men. It pays to retain loyal and efficient employees.

A New Alloy Steel

An alloy imparting to steel toughness, great density, a high elastic limit and ultimate tensile strength, and machinability even when showing qualities of extreme hardness, was developed during the war by Dr. L. P. Burrows. Tests conducted by the Ordnance Department of the United States Navy proved so satisfactory that the alloy was adopted for use in the manufacture of naval artillery material, and is now being made in a half-dozen plants by the open-hearth and crucible methods. The *Iron Trade Review* describes, in its issue for April 7, the process of manufacturing this alloy. Nickeliferous ore obtained in the Sudbury district of Ontario is first crushed and then treated in a revolving cylinder from which oxygen is excluded and into which a gas is introduced containing 89 per cent hydrogen and 10.8 per cent nitrogen. It is then smelted in a crucible or other suitable furnace and then thrown out on the floor. In about 24 hours the product disintegrates into a purple-colored powder. This is refined further and cast in pigs, the yield being estimated at from 1400 to 1600 lb. of metal per ton of ore. The chemical analysis of the alloy is as follows: Silicon, 2.51; iron, 52.89; nickel, 3.98; manganese, 0.046; sulphur, 1.10; cobalt, 0.15; arsenic, 0.11; copper, 0.59; phosphorus, 0.12; tungsten, 0.24; chromium, 2.61 per cent, and varying traces of rare earths and members of the platinum group.

Numerous independent tests of steel containing 1, 1.5 and 2 per cent of the alloy have been made at the Philadelphia and Brooklyn navy yards, several testing laboratories and a number of metallurgical plants. It has been found that specimens with a Brinell hardness of more than 364 are easily machined, a behavior which is contrary to the general assumption that the machinability range lies below 340. Mystery also attaches to the alloy due to the fact that when it is used in electroplating, it seems to impregnate the material instead of merely plating it. There are indications that the material resists corrosion.

Requirements of the Engineering Industries and the Education of Engineers

By MAGNUS W. ALEXANDER,[1] NEW YORK, N. Y., AND DUGALD C. JACKSON,[2] CAMBRIDGE, MASS.

A combination of empiricism and training in rational science is needed in engineering education because it is needed in the engineering industries, and this consideration has led to various plans for placing engineering students within the influence of industrial operation, the most common being for engineering college graduates to enter industrial establishments as "cadets," "engineering apprentices" or "student engineers."

The first comprehensive, organized plan for bridging the gap between academic and practical training of the young engineer was made operative in the United States in 1906 when Herman Schneider, Dean of the Engineering Department at the University of Cincinnati, organized a cooperative engineering course in connection with the metal-manufacturing plants of that city. Schneider's ideas lie at the base of the cooperative plan which the authors succeeded in organizing a few years ago in connection with the Massachusetts Institute of Technology and the Lynn Works of the General Electric Company, and which is described at length in the present paper.

This cooperative engineering course covers a total of five years, the first two being identical with the freshman and sophomore years at the Institute and the last three being divided between instruction in theory at the Institute and instruction in practice at the Lynn Works. In these last three years the total time occupied in studies at the Institute and practice at the Works is eleven months per year. The first term of the cooperative period, extending through thirteen weeks, is spent at the Works by all of the students during the summer period immediately following the sophomore year at the Institute. The succeeding terms of similar duration are spent alternately by each half of the student group at the Institute and at the Works, while the final term is spent by all the students at the Institute for additional advanced instruction and the preparation of a master's thesis prior to the college commencement.

During their assignments at the Lynn Works, students are subject to the usual rules and regulations applying to employees of the General Electric Company, and on a full week's work schedule receive compensation at the rate of $21 per week at the beginning of the course and $24 at the end.

The joint supervisory committee of the two institutions believe that this experiment in cooperative engineering training will exert a most beneficial influence upon the relationship of the engineering college to industry and upon the activities of each. They are clear in their own minds, however, that the cooperative training in engineering must not and cannot replace the regular engineering courses at colleges which in the nature of things must cater to the majority of young men seeking a thorough training in the engineering sciences, and many of whom do not enter the manufacturing industries. The cooperative training, however, is destined to become a vital integral part of a comprehensive system of engineering education, to the detriment of none of the other parts, but to the mutual benefit of all, and is particularly important to the manufacturing industries of the nation.

> Upon the subject of education, not presuming to dictate any plan or system respecting it, I can only say that I view it as the most important subject that we as a people can be engaged in.—ABRAHAM LINCOLN

NO EDUCATION which is sound at base is without vital interest to the engineering industries. Herbert Spencer a generation ago defined the objects of education in five divisions:

1 Those activities which directly minister to self-preservation

2 Those activities which, by securing the necessaries of life, indirectly minister to self-preservation

3 Those activities which have for their end the rearing and disciplining of offspring

4 Those activities which are involved in the maintenance of proper social and political relations

5 Those miscellaneous activities which make up the leisure part of life devoted to the gratification of the tastes and feelings

It is clear that the first three aspects of education are very specific and relate to the individual or to himself and his immediate environment, while the last two are more general and relate as much to the associations of the individual as to the individual and his immediate environment. An education comprising all five aspects qualifies its possessor for "complete living," which, according to Spencer, is the real object of education. That industry is vitally concerned with the first three aspects is quite obvious and easily demonstrated. Thus, propaganda for "safety first" in industrial establishments is an impressive extension to mature workmen, of education for self-preservation which experience impresses on a child almost from birth; and the expense and effort for carrying forward this branch of education would not be sh uldered by industry were it not recognized that the safety of workmen is fundamental both as a matter of humanity and of conservation.

On the other hand, need for securing the necessaries of life is at the root of all industrial production and activity and is the motivating force for elementary work education, while the essence of education for artisanship seeks to broaden and refine this primitive activity. And finally, interest in educational effort for the development of family life, while primarily social in character, is equally important to industry both from the standpoint of self-preservation and the stabilization of man's character arising from family associations and responsibilities.

Industry is therefore vitally concerned with these three primary functions of education, and to the extent to which these aspects are allowed to languish, industry will suffer.

Although primarily of social importance, the two last-named aspects of education according to Spencer, namely, education for good citizenship and for proper enjoyment of leisure, have their bearing and effect upon the conduct of industry. Reason and experience show that successful industrial practice, useful alike to producers and users of industry's products, cannot be long sustained except in communities with a stable citizenship, rooted in a sense of right as between man and man. Wide interest in industrial circles in "Americanization" demonstrates the tacit recognition of the importance of education for thoughtful, steady citizenship. Similarly, not only as part of citizenship development but in its reaction upon the work period of life, the rational enjoyment of leisure as the result of adequate education comes within the domain of industry's interest in education.

In this connection it is significant to reflect that the settlers of New England founded schools and colleges simultaneously with the clearing of the land for their dwellings. These early impulses and policies exerted their influence throughout the later upbuilding of the country, and consequently the establishment of schools has played a notable part in our national development. The hardy frontiersman seldom blazed a trail which schools did not promptly follow.

This record for school education is not peculiar to the American people, but it has been peculiarly universal with them, and a comprehensive educational system has resulted which reaches even to the remote byways of the country. Yet an educational system to meet the needs of our country must be something more than merely a widespread school system in touch with all of the people. The universality of education must be supplemented by those special forms of education which are necessary for the fullest development of each branch of human endeavor and service. In

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satisfaction of this condition a great variety of specialized schools have been established: on the one hand divinity schools, law schools, medical schools, engineering and other professional schools, and on the other, trade schools and vocational schools of various kinds.

Types of Engineers Needed by the Engineering Industries

To conform to the scope of this discussion let us now consider more fully the aim, development, and result of engineering education. In the consideration of any plan of education as preparation for a specific field of activity it is necessary that it be tested with regard to the needs of that field.

What do the engineering industries require in the young men who as engineers are seeking to make this the field of their life work?

Industry is concerned with the transformation of the raw materials of nature into forms more readily adopted to the needs and desires of mankind, through the application of the forces of nature and of man's knowledge and power. This is kinetic in character, a process constantly changing and developing as new materials become available or as new knowledge points the way to improvement.

It is clear, therefore, that first there is need for the pioneers of science, the men to whom we may look to extend the frontiers of knowledge, to delve deeper into the mysteries of nature that new processes may be developed for the utilization and conservation of our natural resources. These men, while having little to do directly with commercial production, must nevertheless have an appreciation of the scope and organization of industry in order that their efforts may be directed along the lines of economic needs. Their chief requirement, however, is a thorough and intimate knowledge of the various branches of science and of the past as well as of more recent developments of practice and theory. As used by engineers, theory means a working hypothesis founded on known facts and experiences which may be utilized to guide progress beyond the margin of past experience. Theory is not antagonistic to practice, but is founded on experience and is a guide to progress.

The second need of industry for engineers arises out of the fact that the advance of industry in the last century has produced an organization of vast complexity and delicacy of adjustment, an organization calling for increasing numbers of efficient executives and administrators. They must be men with industrial training of a high order, competent to conceive, organize and direct extended industrial enterprises of broadly varied character. These men must be keen, straightforward thinkers who see things as they are and who are not misled by fancies; who are capable of quickly grasping the essentials of the many problems that arise, and who are trained in the orderly marshaling and correlating of facts and forces necessary to meet the daily problems that are incident to the functioning of the industrial organism.

But aside from a thorough knowledge of the physical and mathematical sciences, an adequate understanding of human character and of the trend of human progress is essential in order that these engineers may make the most of their abilities. To emphasize this fact it should be realized that over ten million people in this country are spending the major portion of their waking hours in the various processes of industry. This, then, makes it at once apparent how important it is that the engineering schools from which industrial leaders are to be recruited must teach the necessary knowledge of human nature, sound business methods, best means of effectively directing the human forces engaged in industry. Concerned more with the organization, correlation, and administration of mechanisms and productive activities than with the extension of scientific knowledge, they must address themselves in an increasing degree to the problems of the adaptation of the average human abilities to the requirements of those mechanisms and processes; but intimate knowledge of those physical mechanisms and processes must be a part of their intellectual equipment.

Methods of Preparing Prospective Engineers for their Professional Work

Generally the engineering industries need, therefore, three types of engineers: the scientist for discovery and for the instruction in fundamental laws; the practical specialist for application of science to the processes of industry; and the executive for administration and direction of the human forces. With this in mind we may now consider more definitely the problem of engineering education: namely, how most effectively to prepare the prospective engineer for the work he is later to perform.

The average student entering the engineering school at the age of nineteen to twenty-two years, has only a vague and uncertain understanding of the meaning and purposes of industry, and practically no understanding of the problems that will confront him when he enters the industrial field. His usual conception of what the college means is the acquisition of a body of facts handed to him by the teaching staff which in some way he will later on use to advance his own interests. He enters with an alert and inquiring mind and frequently full of enthusiasm for self-expression, but seldom with much unbiased effort at self-analysis or valuation.

Experience has shown that the usual method of taking this human raw material through four or five years of scholastic work without more than casual contact with the practical problems later to be met, frequently results in the neglect of, or superficial attention to, many of the studies essential to subsequent progress. Not infrequently it also results in a long and discouraging period of readjustment after graduation, during which the new engineer-recruit often endeavors to adjust industry to some of his false conceptions rather than to adjust himself to the new life he is entering.

There are two methods by which the engineer can acquire the knowledge needed for his professional work: the *rational*, wherein the solution of problems is obtained by means of direct reasoning from definite premises; and the *empirical*, which is based on experience and observation, and reasoning by balance of evidence. In certain fields of engineering the subjects dealt with are so complex and the knowledge regarding them so fragmentary that empirical or experimental methods must be resorted to almost wholly. In other fields the subjects are so open to analytical processes of reasoning, and knowledge regarding them is so well organized, that purely rational methods suffice for adequate solutions. In most instances, however, the conditions are such that a combination of the rational and empirical procedures should be used.

Broadly speaking, our engineering schools and colleges emphasize the former, while engineering practice depends largely on the latter. Rational methods are typified and developed by the study of the sciences, such as mathematics, physics and chemistry; and empirical methods are exemplified in the education derived from direct association with, and participation in, the activities and processes of industry. A combination of empiricism and training in rational science is needed in engineering education because it is needed in the engineering industries. A better balance must be established between the teaching of the sciences in the colleges, which should emphasize this part of education and resist any attempt to diminish its effectiveness, and practical education in industrial establishments, where it is rooted in production with consequent better appreciation of the value of time and money as elements of industrial activity.

This consideration has led to various plans for placing engineering students within the influence of industrial operation. The most common way is for engineering college graduates to enter industrial establishments as "cadets," "engineering apprentices" or "student engineers;" and sometimes engineering education during the undergraduate course is supplemented by practical industrial employment during the summer months. The value of the latter method of interweaving engineering practice with engineering education was emphasized by the late Frederick W. Taylor, man of genius and Past-President of The American Society of Mechanical Engineers, who advocated that each engineering student be required to spend a year or more in commercial shop employment before the end of his course of study in the college. Taylor recognized the weakness of the tandem relation of the college course and the subsequent student apprentice employment, and by his proposal approached the condition of intimately interlacing the time of these two. It is evident that European experience and practices served to stimulate his thought along these lines.

The West of Scotland Technical School for a long time has required its students to spend a period in the factories before completing their studies at the college. A like plan has long been in effect at the Royal Polytechnic School of Denmark and at similar engineering schools in other parts of Europe. Faraday House, a British school of electrical engineering, alternates its students in yearly intervals between the formal school and commercial engineering plants.

In the year 1906 the late Sir William White added all the weight of his great name and influence in British industrial circles to a report urging the importance to engineering students of interchanging time between the engineering school and engineering establishments.

THE SCHNEIDER PLAN FOR A COÖPERATIVE ENGINEERING COURSE

In the same year the first comprehensive, organized plan for bridging the gap between academic and practical training of the young engineer was made operative in the United States when Herman Schneider, Dean of the Engineering Department of the University of Cincinnati, organized a coöperative engineering course in connection with the metal-manufacturing plants of that city. Prior to this, most of the engineering schools in the United States had urged their students to secure engineering employment during their summer vacations, and some had gone so far as to establish a system for crediting required work in the practice shops of the school by machine-shop employment during vacations, provided it was secured in approved shops and the factory superintendent certified to the extent, character, and satisfactory grade of work done by the individual student.

Schneider's plan is comprehensively dealt with by C. R. Mann in his important and suggestive report on Engineering Education issued in 1918 by the Carnegie Foundation for the Advancement of Teaching, in which The American Society of Mechanical Engineers took a part by participation in the Joint Committee advising the work. The report in part says:

> The Cincinnati plan was first formulated by Herman Schneider in 1899 while he was an instructor in civil engineering at Lehigh University. In 1902 Schneider presented a full statement of his scheme to the directors of several large industrial firms which were considering the establishment at Pittsburgh of a new technical school to give engineering training that would be better suited to industrial needs than that then given in the engineering colleges. This plan was abandoned when Mr. Carnegie founded the Carnegie Institute of Technology in the city of Pittsburgh. Finally in 1906 Dean Schneider found an opportunity to make his experiment at the University of Cincinnati.
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> The mechanism of the scheme is very simple. The students are divided into two groups, one of which is assigned to work in industrial plants while the other goes to school. At the end of each bi-weekly period the two groups change places so that the shops and the school are always fully manned. In the shops the students work as regular workmen for pay, but the nature of their work and the length of time each stays on any particular job are subject to approval by the university. The emphasis of the school work is on theory and principles, but these are well interrelated with the shop work by "coördinators" who visit each student during each shop period and then meet the several groups during the university periods in special "coördination" classes for this purpose.
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> The curriculum is completed in five years of eleven months each, so that each student receives twenty-seven months of university instruction. Since the regular four-year curriculum in other schools requires about thirty-six months of actual instruction, it would seem at first glance that the Cincinnati curriculum could not give as full a training in fundamentals as is given elsewhere. This inference, however, is wholly unwarranted because in the twenty-seven months of industrial work the student gets a vast amount of practical knowledge which is given in other schools in information courses, and because of the close coördination with practice which makes the theory more intelligible and significant to the students. The graduates of Cincinnati have unquestionably as extensive a training in theory as have those of other first-class schools. In addition, the Cincinnati graduates are able to command engineering positions at graduation without one- or two-year "apprentice" courses such as are required of men from other schools by the large corporations. . . .
>
> Schneider's experiment is clearly much more than a novel and inexpensive method of handling the shop work. It is an effort to create a type of school that meets the demands of an industrial age. It frankly recognizes that the present need is for masters of materials who can humanize industry. It tries to emphasize rather than to discourage the appraisement of values and costs, and endeavors to express idealism in the economics of life rather than build ideals that are unrelated to human experience.

Schneider's ideas have since been followed in the establishment of coöperative engineering courses at several educational institutions, and they lie at the base of the coöperative plan which the authors of this paper succeeded in organizing a few years ago in connection with the Massachusetts Institute of Technology and the Lynn Works of the General Electric Company.

Whatever weaknesses in major features or in detailed application Schneider's plan may possess, unstinted praise must be given him for his conception of the idea as far back as 1899, and for his persistence in pressing the proposal to a practical consummation in 1906.

Growing out of a close study of industrial and engineering educational methods as they seemed to be demanded by American industry, and stimulated by the development of the coöperative engineering course at the University of Cincinnati the paper was presented in 1908 at the Atlantic City convention of the American Institute of Electrical Engineers entitled The New Method of Training Engineers.[1] In this paper the merits and value of coöperative engineering education are analyzed and a strong plea is made for joint effort of college and industry for the comprehensive education of engineers. The paper deals somewhat at length with the method of interlacing theory and practice and the most advantageous time allowances for each. Arguments are advanced against the short periods of alternation between college work and industrial employment established under Schneider's plan—alternations at first of one week's duration, and later of two weeks' duration—and an improvement is suggested based on alternating periods of at least four or five weeks at the beginning, and of college semesters toward the end, of the coöperative course, with a full year of college training as a finishing work. Because the arguments then advanced in favor of longer periods of academic and practical instruction and in support of other major features of coöperative engineering education are pertinent to the discussion of the plan now submitted, the views expressed in that paper are briefly summarized here, as follows:

A serious study of this situation has led to the belief that the best engineering education can be obtained under a plan which provides that the teaching of the theory and practice should go hand in hand, and, so far as practicable, successive steps in the one should be based on similar advances made in the other, at such intervals as to permit of the most advantageous interplay of the two; and further, that the colleges should devote their whole time to the teaching of the theory for which they are so eminently adapted, leaving it to real workshops to initiate the student into practical work, for which they in turn are best equipped. From an educational standpoint this plan should prove efficacious, for mental conception of any activity is facilitated by the physical perception of a given process, as illustrated in the whole development of the human being; and on the other hand, mental visions are more firmly clinched by concrete application. Moreover, under such a plan the freedom enjoyed by students during the college career is happily interrupted by the stern discipline that must prevail in a business organization. This plan also trains and develops the young man in the very life to which he will devote his future efforts and gives him the love for it, which, after all, is necessary for his success. An arrangement of this kind, carrying with it financial remuneration during a part of the time, will attract to the engineering industries young men who are mentally and physically adapted, but who at the present time do not enter college for financial reasons or for lack of appreciation of the value of higher education. The poor boy, if otherwise fitted for it, will be given a chance to acquire a college education by "working his way" through college in activities that have a direct beneficial bearing on his future career. The influence of the college will therefore be extended and in no way restricted by the coöperative plan as contemplated.

The length of the alternating period is a very important element in this plan, for too long or too short a time may defeat the very objects which the coöperative course seeks to accomplish. In the light of the aims of the course previously advanced, short periods seem to recommend themselves. A year or even six months spent alternatingly at college and at the factory would, it is believed, fail to give that close coördination of theory and practice that is an essential feature of the plan; nor would it establish that balance between the college freedom and the factory discipline which has already been referred to as very desirable. Short

[1] Magnus W. Alexander, Trans. Am.Inst.E.E., vol. 27, p. 1459.

periods, on the other hand, will develop that facility in the young man's physical and mental make-up that will enable him to adjust himself quickly to the interacting influence of the college and the factory. The engineering apprentice should enter upon his factory work as a college boy with all the mental alertness and the inquiring mind fostered by the college; and he should return to the college as an industrial worker with the physical energy and the determined spirit of achievement that will be developed in a hustling factory organization. The attainment of these characteristics will to a large degree determine the success of the plan. Alternating periods of a day or even a week, to take the other extreme, might keep the young man's mind in a rather chaotic state, might not give the seed sown in the classroom and factory, respectively, a fair chance to take root. Such time arrangement, moreover, would seriously interfere with the best economy at the factory, and largely forfeit that sympathetic interest of the shop foremen and workmen which is not only desirable but decidedly necessary.

Attention is also called to the efficacy of an arrangement under which the periods increase in duration from the first toward the last year of the course, beginning perhaps with alternations of four or five weeks and ending with time elements of college semesters. In that way all the advantages of the coöperative course would be emphasized strongly at the beginning when they are of determining influence, and the economic consideration of the college and the factory would receive growing attention in later years as justified by the increasing importance of the work.

Coöperative Engineering Course Between the Massachusetts Institute of Technology and the General Electric Company's Lynn Works

This proposal of 1908 as above outlined in summary was seriously considered by a committee of representatives of the Massachusetts Institute of Technology and of the General Electric Company and was finally accepted by both institutions after the sympathetic coöperation of the president and the faculty of the Institute on the one hand, and of the officers of the company on the other, had been secured. Freshmen acceptable to both institutions were to be started on a six-year coöperative course with half of the total number of students in this course spending alternating periods of from six to nine weeks at the Institute and at the workshops of the General Electric Company, respectively. Meanwhile, however, the business depression of 1913 had set in and made postponement of the educational experiment advisable, affording at the same time opportunity for further reflection and study. This led to important modifications of the original plan, the principal one being that of accepting juniors rather than freshmen for the course, lengthening the alternating periods between college and factory to approximately three months' duration, and making the coöperative course last three years, predicated on a two years' college preparation but leading directly to the Master's Degree in Science. While the coöperative engineering students were to be recruited from the Electrical Engineering Department of the Massachusetts Institute of Technology, it was then clearly understood that the same privileges and the same conditions should later be extended to the students of the Mechanical Engineering Department and that in the future no difference should be made as between the two; it was also agreed that students from other colleges should be eligible for the coöperative engineering course if they could qualify for junior work at the Institute.

The advantages of these modifications appealed strongly to both institutions and a coöperative engineering course between the Massachusetts Institute of Technology and the Lynn Works of the General Electric Company was actually started in the summer of 1917 with a class of thirty students. Right from the beginning the experiment showed the earmarks of success and during the first year of its operation gained the support of the interested parties in both institutions. The exigencies of the war, however, in which the United States had meanwhile become involved, and especially the rules of the Students' Army Training Corps, the S.A.T.C., requiring all engineering students of draft age to be under military command and subject to drill, again interfered with the progress of the coöperative engineering course and necessitated its temporary relinquishment in the summer of 1918.

Undaunted by these unfortunate but unavoidable interruptions and more than ever believing in the efficacy of the proposed plan and in its value as an experiment in engineering education, the officers of the Massachusetts Institute of Technology and of the General Electric Company seized upon the opportunity offered by the cessation of war activities and the return to more or less normal conditions, and in the summer of 1919 reinstated the coöperative engineering course which has since continued in operation on an enlarged scale. Experience with this plan for now practically two years indicates quite clearly that, barring slight changes which may become advisable in the course of time, the plan itself is built on a sound basis of good pedagogy and good business principles. It would seem appropriate, therefore, to discuss here the principal features of the plan and the results so far achieved.

By agreement of the two institutions involved, a joint committee was appointed to supervise the coöperative engineering course and to make such changes within the limits of the accepted plan as may from time to time become advisable. The committee is headed by Dr. Frederick P. Fish, equally known as the country's most eminent attorney at the patent bar and as a keen student of educational methods and participant in their development, and moreover a directing factor in the councils of both institutions. Associated with him are, representing the Massachusetts Institute of Technology, Prof. Dugald C. Jackson and Prof. Frank A. Laws, the latter having taken the place of Prof. Comfort A. Adams; and representing the General Electric Company, Dr. Elihu Thompson and Mr. Magnus W. Alexander. In addition, Prof. W. H. Timbie of the Institute was selected to work in close and almost daily contact with Mr. Charles K. Tripp, the official in charge of the educational courses at the Lynn Works, in supervising the progress of the students and looking after all necessary administrative details, including the proper housing of the students and the conduct of certain lecture courses each week for the students on assignment at the Lynn Works.

As stated before, the coöperative engineering course covers a total of five years, the first two being identical with the freshman and sophomore years at the Institute and the last three being divided between instruction in theory at the Institute and instruction in practice at the Lynn Works. In these last three years the total time occupied in studies at the Institute and practice at the Works is eleven months per year, so that the students are provided with one month of vacation each year. In a general way, in the first four years of the coöperative course, the Institute covers instruction similar in method and content to the usual four-year engineering course, with certain omissions and abridgments for which equivalents are provided at the Lynn Works. During the final or fifth year of the coöperative course, however, the Institute gives advanced or post-graduate instruction in research and creative design. On the other hand, the training at the Lynn Works is laid out and conducted with a primary view to its educational value and is closely correlated with the instruction at the Institute; with it all, however, the instruction is eminently practical in character and is on the surface as little as possible differentiated from the regular work of the General Electric Company. In this way the coöperative students not only perform work as it is performed by and demanded of a commercial industrial establishment of recognized standing, but they perform it under the same conditions and in connection with the same types of co-workers, high and low in rank, as those with whom they will be associated in their daily work when they will have finally taken their places as engineers and managers in industry.

Juniors from the Massachusetts Institute of Technology, or students from any other engineering school who are eligible as juniors at the Institute, may enter upon the coöperative engineering course if they are also acceptable to the supervising official at the Lynn Works, and they may continue in the course as long as their work and deportment are satisfactory to both institutions. If a student should at any time during the course so fail to satisfy either institution as to make his separation from either advisable, he is automatically dropped by both from the coöperative engineering course—without any prejudice, however, as to his continuance in other employment at the Institute or at the Works.

The first term of the coöperative period, extending through thirteen weeks, is spent at the Works by all of the students during the summer period immediately following the sophomore year at the Institute. The succeeding terms of similar duration are spent alternately by each half of the student group at the Institute and at the Works, while the final term is spent by all the students at the Institute for additional advanced instruction and the preparation of a master's thesis prior to the college commencement. An opportunity for an additional optional summer term of engineering and research assignments at the Works will be open to those graduates of the coöperative engineering course who desire to elect it.

This arrangement offers several advantages. It gives to the Works an opportunity during the initial shop assignment to test all students as to their adaptability to practical work and for their general character; and allows rejected students or those who may then voluntarily withdraw from the coöperative course to enter the regular junior class at the Institute at the proper time. At the other end of the course it brings both groups of students together for nine weeks of intense application to original research and to thesis work, and permits of the formation of closer college associations and the development of a broader college spirit. Thus, each coöperative student class commences and finishes the course at the same time for all members.

On the other hand, the division of the intervening time of substantially two and one-half years of coöperative training into periods of thirteen-weeks' duration enables the students to complete one or two assignments at the Works within each period and to fit into the standard classes at the Institute. The advantages from a pedagogical, practical, and economical point of view are obvious. Each thirteen-weeks' period assigned to the Institute comprises eleven weeks of classroom attendance and two weeks of vacation, thus giving each student a vacation of two weeks twice each year. These vacations are not so much for recreational purposes—for the complete change in character of work after each period provides in itself recreation—but more for the sake of gradual change of emphasis from taxing mental work without physical strain to that of essentially physical effort for the achievement of an intellectual purpose. The robust health of the coöperative students and their marked mental agility while at the Institute furnish corroborating evidence of the wisdom of the plan.

In order, however, to keep the mind active during the assignment at the Works so as to avoid, as far as possible, the necessity of taking up a slack at the beginning of the Institute periods, all coöperative students are required to attend lecture courses and to do a certain amount of scholastic work while at the Works. To this end members of the Institute faculty are devoting certain evenings each week at Lynn to the teaching of electrical engineering subjects, English, and accounting, thus making the study of electrical engineering theory continuous throughout the three years of coöperative training, so arranged that theory and practice are linked with each other step by step as far as this is practicable. Similarly the continued study of English has for its main purpose the training of the potential engineers in effective speaking and writing, and the enlarging of their interest in human activities generally, while the addition of instruction in accounting is for the purpose of emphasizing the importance of considering time and cost, and for giving familiarity with the statistical methods of keeping record of the same. The coöperative students, while at the Works, are also expected to devote part of their evenings and Saturday afternoons to selected reading collateral to their scholastic training.

In addition, the managers and superintendents in charge of various departments at the Lynn Works give weekly lectures on different phases of manufacturing methods and business practices. The students are therefore obtaining first-hand engineering and business information of an eminently practical character and are brought into personal contact with the leading officials at the Works. It is obvious that this system of study and lecture service, combined with the weekly practical work schedule, contributes not only to the students' technical knowledge and literary appreciation, but also keeps them in a mentally alert condition. This, in turn, reflects itself, as experience has shown, in the wide-awake attitude of these students when they return to the Institute for their college assignments; and the Institute faculty members recognize this as an observed effect.

Briefly outlined, the curriculum of the coöperative engineering course comprises substantially thirteen weeks of machine-shop training, assembling and inspecting; five weeks of practical work in winding and insulating electrical elements of machinery and apparatus; thirteen weeks of drafting and designing experience; twenty-one weeks of testing of meters, motors, generators, transformers and steam turbines, and twenty-six weeks of practical engineering and research assignments in the various engineering departments of the Works.

On the side of the Institute work the curriculum provides for the usual program of regular junior and senior classes in the Institute's engineering departments, minus certain parts of the standard curriculum which can more effectively be taken care of at the Works, such as drafting and designing, testing and calibrating, and some of the engineering laboratory work. On the other hand, during the last Institute assignment of nine weeks coöperative students are given training in business law and organization and, as already stated, are afforded the necessary time and facilities for their master's-degree thesis.

The study and lecture system, linked up with the practical work while the students are at the Lynn Works, is facilitated greatly by the arrangement under which coöperative students are given opportunity, even though they are not obliged, to live at a well-situated club house at Lynn. This club house is now given over entirely to the use of coöperative students. It provides adequate facilities for lecture and study purposes. A similar residence is provided for the students while at the Institute, thereby facilitating the interchange of residence between the two locations.

During their assignments at the Lynn Works students are subject to the usual rules and regulations applying to employees of the General Electric Company, including a reasonable physical examination by the company's Works physician. The periods of rather strict discipline at the Works are a happy offset to the alternating periods of greater freedom at the Institute, save for the observance of regular college discipline during lecture courses and laboratory assignments. In addition, because now living under the discipline that a commercial establishment must exact of its working force, the coöperative students will, when they have been graduated into managers and leaders of men, be in a better position to prescribe and enforce discipline of others with wisdom and discretion.

Compensation is paid to coöperative students during their assignments at the Works. On a full week's regular work schedule this compensation amounts now to $21 per week at the beginning and $24 per week at the end of the course, these rates having been increased by $6 and $4, respectively, from the rates originally established.

The coöperative class which started in the summer of 1919 numbered 28, of whom 27 are still in the course preparing to enter the third and last year of the coöperative training within a few weeks. The class which entered in the summer of 1920 numbered 54, of whom all are still pursuing the coöperative training. It is the intention to start a third class this coming July, and there seems to be no doubt in the minds of the supervising committee and the officials of the two interested institutions that an entering class of from 40 to 60 students will be selected and provided for each coming year, so as to continue the flow of students through the course.

As stated before, the Institute faculty is heartily approving the coöperative engineering course. The officials of the General Electric Company are equally convinced of the efficacy of the plan. What is more significant, however, is that the superintendents and foremen, and even section leaders and individual workmen, are cheerfully doing their part to help the coöperative students in their work. The supervisory committee believe that this experiment in coöperative engineering training will exert a most beneficial influence upon the relationship of the engineering college to industry, and upon the activities of each. All parties, however, are clear in their own minds that the coöperative training in engineering must not and cannot replace the regular engineering courses at colleges which in the nature of things must cater to the majority of young

(*Continued on page 397*)

The Rise of the Industrial Worker in an Organized Society[1]

By IRA N. HOLLIS,[2] WORCESTER, MASS.

MANY volumes wouldbe required to deal adequately with the great industrial upheaval that has taken place since James Watt applied the steam engine to a rotating shaft in 1781. The information at the present time is meager and statistics are almost valueless. It will be reserved for some future historian to write about the rise of the industrial worker after he had either emerged from this period of doubt and conflict or pushed upward into the control of society. We can see evidences of change and we can understand well what is meant by industrial warfare, a warfare that would have involved much bloodshed a few centuries ago, but happily now, through our conception of democracy, is taking place without bloodshed and in most cases without evil memories and evil deeds. We can only hope here to indicate the size of the problem ahead of society in this twentieth century.

A short paragraph in Daniel Webster's speech against Hayne expresses fairly accurately our position today:

> . . . When the mariner has been tossed for many days in thick weather and on an unknown sea, he naturally avails himself of the first pause in the storm, the earliest glance of the sun, to take his latitude and ascertain how far the elements have driven him from his true course. Let us imitate this prudence and before we float farther, refer to the point from which we departed that we may at least be able to conjecture where we now are.

He might also have added, "to determine the course that we had been following since the last observation of the sun was taken." Our country is in the troubled sea and the clouds have completely cut off the sun, so that we truly are in the position of the puzzled mariner who knows neither his course nor his place on the ocean.

Who are the industrial workers of America? As a matter of fact we all are, except a few who by inheritance are freed from the anxiety of the shifting industries. The man who receives a large salary usually works harder than the man who receives a small salary, and in addition has to stand the constant wear of responsibility. Why should a distinction be drawn between wages and salaries? It does not make much difference whether a man is paid by the hour, the day, the week, the month, or the year; he must always have some employer to please. The common laborer is more fortunate than the professional man in that he usually has only one employer, while the professional man has many, and he draws his pay only in proportion to his service. The piece worker and the professional worker are on exactly the same level and obtain their wages by practically the same method, the only difference being the character of the work.

Too much has been said about capitalistic government. Capital usually represents the hard-earned wealth of those who were frugal and careful. It is true that there are some who have taken advantage of the development of recently discovered raw materials or resources or inventions, but in the main, all the people in the United States are capitalists. In many cases the workmen themselves who have been foresighted have accumulated some capital, and in most cases an industry in the United States represents the effort of some one who began at the bottom.

We know also the enormous expansion of invention made possible through the application of mechanical energy. This has been largely material and there is no evidence whatever that man has advanced either morally or ethically since the Constitution of the United States was written.

We are trying out a social evolution on a great scale which can be tested only through the lapse of many years and the complete readjustment of society to the new forces in our hands. In this change one class cannot be considered as separated entirely from another, and when we speak of the rise of the industrial worker we must at the same time consider his relation to others.

We may study this subject under five general heads:

1 The increase in numbers of the industrial workers
2 Their gain in power through combination
3 Their wealth
4 The opportunities for advancement
5 The satisfactions in life derived from their occupations.

It is upon the latter that I really prefer to dwell; as after all the success of any great change is measured by its permanent influence over the happiness and the mental attitude of society toward life.

Increase in Numbers of Workers

There has without doubt been an increase in the number of industrial workers since our Civil War, but the relative increase is largely a matter of definition. The term "industrial worker" has come to mean something quite different from the domestic workers of the eighteenth century, and consequently it is hard to make a comparison even between years so short a distance apart. The increase of labor-saving machinery would, if the only influence, reduce the number of workers and turn them to agriculture or other avenues, but with invention there has come more than a corresponding increase in the standard of living and the demands for manufactured articles, increasing the number of workers. In the automobile industry alone we have now nine million workers as against none in 1861.

Gain in Power Through Combination

It is evident that the power through organization of a minority has increased enormously. In some respects this has benefited all labor. In other respects it is a threat, because it is the strength of minority in a government which has as its ideals the predominance of the majority.

The power of the unorganized industrial worker has been found in the vote of quiet citizens who do not follow radical leaders and who have not felt the need of pressure by a central organization to better their conditions.

The power of organization stands out plainly, as we have at present the ruling of this country, at least in part, by minorities. That is what invention has done for us. By the use of labor-saving machinery and the change from the old type of mechanic to the specialist, we have built up enormous aggregations of capital and of labor. Wherever these exist, monopoly is possible, and control by the minority is also likely.

One of the directions in which the power of labor organization has been felt is in the reduction of hours. That has followed naturally upon the use of mechanical energy, and every individual in the United States is entitled to his share of the gain that has followed from putting our work into the hands of machine slaves. While it is not necessary to go into details of calculation, the potential power of America is between three and four thousand million men. That is based upon mechanical energy and all other forms outside of the human body. It follows at once that every inhabitant inherits the benefit of between thirty and forty manpower, or, as I have called it, thirty and forty "machine slaves." We, as citizens of the republic, are determined that this benefit shall not be obtained by a few, hence the difficult period through which we are passing. The hours of labor ought to have been reduced, and it is possible that with increasing invention they can be reduced still more.

In summing up this matter of power and the rise in power, it may be said that there are two methods by which this power may be exerted:

1 The quiet vote of the great majority of workmen who are following the constitutional system of representative government without pledging themselves first to fealty toward a union or an organization;

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[1]Abstract of address delivered March 25, 1921, at a joint meeting of the New York Section of the American Institute of Electrical Engineers and the Metropolitan Section of The American Society of Mechanical Engineers.

[2]President, Worcester Polytechnic Institute. Past-President Am.Soc. M.E.

2 The organization of a minority for united action, either by holding the balance of power or by controlling through actual force certain agencies of our Government.

WEALTH OF THE WORKERS

The gain in wealth of any community or state is measured by the conditions of life, and usually it is quite impossible to separate one class from another. Has labor made any substantial gain? It is doubtful if the average individual in labor is better off today than he was sixty years ago in the sense of being contented, but it is probable that a vastly larger number of laboring people are comparatively well off. The fact is that America has never had any of the great poverty that existed in Europe because we came to a country which God had endowed with boundless resources not yet used by man.

A fair measure of gain may be perhaps afforded by the savings banks. Are the deposits greater than they were sixty years ago in proportion to the population? Without question they are. Many places where there is large manufacture have shown enormous gains. We may conclude, though, that labor has risen in wealth during the past century simply because the standard of living is vastly in advance of anything our ancestors could have imagined.

OPPORTUNITY FOR ADVANCEMENT

After all, we get down to real values as we leave the numbers, the power, and the wealth of the industrial workers. The most important thing in this life is opportunity.

The machinery of mechanical energy has opened the way to undreamed-of achievement, and every individual should find it possible by his work to do better for himself than ever before in the history of the world. In our experience it is true that a man may rise out of the ranks more readily than ever before. Opportunity is better than ever before. That is a true measure of the rise and the kind of advance which carries civilization along with it. I know of no more interesting history than that of the industrial communities in the United States. In one of them where I live, almost every factory is founded on the energy, enterprise, and character of workmen who sprang up among us. When we talk of the closed shop as a means of shutting out non-union labor, we are simply taking a step backward and absolutely laying a barrage through which individual enterprise cannot pass. One of the things that labor should not forget is that many of the men against whom they are endeavoring to legislate, as the managers or the capitalists, have been like themselves ordinary workmen who have taken advantage of the opportunities afforded through this democracy.

The curse of our modern controversy on the subject of capitalism or capitalistic government springs out of a total misunderstanding of what opportunity means. When the present governing classes in Russia speak of the bourgeois with a certain amount of contempt, they refer to the people whose families made Russia. Are we drifting backward here toward that form of government or are we going ahead in developing opportunities and openings for men to rise out of the ranks? No statistics can tell that. It is impossible to answer the question satisfactorily, but we do know that when the time comes that a man's right to make a living shall be judged solely by his membership in an association, in a church, in a political party or otherwise, then our Government is in danger.

The gathering power of labor may be summed up through the disappearance of monopoly. In the decision as to conditions under which labor has to be carried out, the disappearance of political democracy as the prime essential of government and the appearance of an industrial consciousness will do more than make this world safe for democracy. It will adapt democracy to work a new form of government which the twentieth century must work out, and in which the engineer must have a voice in order that the test of opportunity may become a reality instead of a shadow upon the first page of our own national Constitution.

SATISFACTION FROM OCCUPATION

We are certain of one thing, and that is that no citizens can take any satisfaction or feel happy with the present condition of warfare in the United States. The "get together" spirit is passing even from the churches, although there is some indication that certain sects are prepared to coöperate. There has never been a time of greater restlessness or discontent in the whole world. The United States is feeling the effect of it, but on the other hand there has never been a time of greater responsibility for the human race. It is perfectly proper, then, to inquire in this connection what are the satisfactions of life and what effect are they going to have on the happiness or the continuance of the race? What are they going to do for the industrial worker? Through them is he going to have a true rise and influence over the future of our Government, or is he simply going to sink to the level of the poor, struggling mortals of an outworn century? I have put the whole thing down in a formula that no one can be satisfied unless he has served, and he can serve only through work.

I ran across some sentences in Spencer's Ethics a few days ago, and one of these I put down here as written when Spencer was a young man. I omit a large part of the paragraph and take only the words that apply to the subject under discussion: "The growth of voluntary coöperation has been necessarily accompanied by decrease of aggression and by an increase of sympathy leading to services beyond agreement." Could anything define better what should be the true rise of the industrial worker? "Services beyond agreement;" where do we find them today, through the labor organizations or through the employers? In this advancing power of the industrial organization more attention has been paid to control than to service. Little has been done to better the lot of working men and women in the nature of the higher satisfaction that follows through better preparation for service. The tendency has been quite the other way.

The rise of any human effort or agency is measured by its tendency to minister to the satisfactions of life. No gain in numbers, power, or wealth that does not accomplish this is a permanent gain. It must pass away.

REQUIREMENTS OF THE ENGINEERING INDUSTRIES AND THE EDUCATION OF THE ENGINEER

(Continued from page 395)

men seeking a thorough training in the engineering sciences, and many of whom do not enter the manufacturing industries. The coöperative engineering training, however, is destined to become a vital integral part of a comprehensive system of engineering education, to the detriment of none of the other parts, but to the mutual benefit of all, and is particularly important to the manufacturing industries of the nation.

The pragmatic test, of course, will come for this plan, when the first group of coöperative engineering students will have been graduated and will have taken their rightful place in industry. It will then be seen to what extent these graduates will more quickly fit themselves into and become effective leaders of that branch of industry which calls for practical engineers accustomed to applying the technical sciences to the needs and wants of the human race, equipped by their understanding of human nature to coördinate human forces and to inspire them with their leadership, and endowed with that vision which will permit American engineering industries to develop to the greatest benefit of all engaged therein and to the glory of our country.

The project is planned to afford a definite professional education of a high order leading toward the technical and executive responsibilities in industry. In order that this ideal shall be accomplished, several factors must contribute to the desired end. The engineering college should have a notable capacity for teaching the exact sciences, and also sympathize with coöperation by means of which its students may obtain coördinated experience and instruction in practical employment. The officers and department heads of the industries participating in the coöperative arrangement must also correctly appraise the advantage to leadership in industrial engineering of a rational scientific as well as a practical training. Given these relations and a readiness to enter into mutual supervision of the enterprise, a foundation for success is laid.

SURVEY OF ENGINEERING PROGRESS

A Review of Attainment in Mechanical Engineering and Related Fields

The Failure of Metals Under Internal and Prolonged Stress

AT A JOINT MEETING of the Faraday Society, the Institution of Mechanical Engineers, the Iron and Steel Institute, the Institute of Metals, the North-East Coast Institution of Engineers and Shipbuilders, the West of Scotland Iron and Steel Institute, and the Institution of Engineers and Shipbuilders in Scotland, held in London on April 6, the subject of failure of metals under internal and prolonged stress was discussed.

In an introductory address, Dr. W. Rosenhain surveyed the nature of the problems before the meeting and their actual position. He related some experiments he had performed to investigate the time element in tension testing, and ascribed season cracking to viscous flow in the amorphous intercrystalline layer found in metals. An aluminum alloy having a tensile strength of 24 tons per sq. in. ruptured under that load in 2 min., but supported loads of 16 tons, 14 tons and 13 tons per sq. in. for 9 min., 31 min., and 56 min., respectively. This time effect, however, was only associated with intercrystalline fracture. Dr. Rosenhain projected on the screen photomicrographs which, he believed, confirmed the hypothesis explaining season cracking by viscous flow. His slides showed that crystals with smooth regular boundaries were easily cracked, and that when the same material was treated so as to make the boundaries irregular it would not undergo intercrystalline cracking under any circumstances. In confirmation of his argument, Dr. Rosenhain pointed out that ordinary wires would, if twisted, not quite reacquire their original position when released; but if the wire consisted of a single crystal the return was immediate and complete, because then there was no seat for viscous phenomena in any intercrystalline boundary. In his final remarks the speaker referred to the opinion of metallurgists who explain intercrystalline cracking as a result of chemical action. He experimented with metal strips which were annealed in different media, some in air, moist or dry, some in hydrogen, and some in vacuo. Season cracking occurred in all although much sooner in those treated in air than in those treated in vacuo or in hydrogen. This, he said, proved that season cracking took place in the absence of chemical action.

Fourteen technical papers were presented, of which excerpts from seven are given below. (Others will be abstracted later in this section if space proves to be available.)

CHEMICAL INFLUENCES IN THE FAILURE OF METALS UNDER STRESS

By Cecil H. Desch

There are two directions in which the failure of metals under stress may be influenced by chemical conditions, the first being through the composition of the metal or alloy, and the second through contact with a substance which is capable of reacting chemically with the metal. The first of these has not been systematically investigated. The form of failure known as "season cracking" appears to be confined to a limited class of alloys, principally brasses and alloys of copper with zinc and nickel. In the brasses the liability to crack under continued stress appears to increase with increasing zinc content and to be favored by the introduction of iron or tin. On the other hand, intercrystalline failure under the application of stress may take place in many other metals, including steel, in such circumstances as to indicate a relation to season cracking. Brasses composed of the better constituent occasionally crack in the cast condition, without the application of external stress, and this form of failure is always associated with the presence of aluminum in the brass. The influence of corroding agents has been rather more fully studied. The most striking feature of this action is its specific character. In the case of severely cold-worked metals in a state of internal stress, cracking may be produced by contact with solutions of mercury salts or with ammonia, but only rarely by any other reagent, although acids may attack the metal much more rapidly than either of these. The difference between reagents in this respect does not appear to be merely one of degree, but the strictly selective action of certain compounds is very remarkable. Chemical action in metals frequently advances along the surfaces which separate the crystal grains more rapidly than through the mass of the metal, and such a course is more likely to occur when the portion of the metal which is exposed to the reagent is in a state of tension than when it is in compression or in an unstressed condition. At the same time, this process is not observed with all reagents. The action of strong acids is so powerful that the minor differences between the crystal boundaries are obliterated, but their mode of action may be intercrystalline when the metal attacked is in a highly cold-worked condition. The action of weak electrolytes is usually intercrystalline. Mercury is the most powerful reagent for separating the crystal grains at the ordinary temperature. Tin and other fusible metals behave like mercury at higher temperatures. None of these reagents, however, can produce an intercrystalline weakness which does not previously exist, but only reveals, either a state of stress, as in the cold-worked metals which are subject to season cracking, or a state of weakness of unknown origin, as in some large castings of propeller alloys. (*Engineering*, vol. 111, no. 2884, April 8, 1921, p. 418, *g*)

INTERCRYSTALLINE FRACTURE IN STEEL

By D. Hanson

A description of four cases in which steel developed intercrystalline cracking, and a consideration of the general causes of season cracking. The first case was that of a steel wrapper plate from the combustion chamber of a marine boiler, which was severely cracked around the edges between the rivet holes. The chemical composition of the plate was not unusual, although the phosphorus content was 0.7 per cent. Tensile tests gave normal results for the center portions of the plate, but the edges showed a low elastic limit and elongation, while notched-bar impact tests gave variable and low results. Microscopic examination revealed the fact that the cementite occurred mainly in the form of intercrystalline films. The second case was drawn from the drum of a water-tube boiler, and the cracks as before started mainly from the edges of the rivet holes, though some were found to start at the calked edge of the plate. Microscopic examination showed the existence of intercrystalline films of cementite. The third case was found in a number of plates from a high-pressure marine boiler. In this case intercrystalline cracks were found in the steel at a point where the thickness of metal was 4 in., including the wrapper plate of the boiler, two butt straps and a cover plate. Failure is attributed in these three cases to the probable existence of internal stresses in the material. Another case of intercrystalline failure, in which internal stresses appeared to have been present in the metal, was that of a piece of cold-drawn steel tubing which cracked after six months intermittent service without working stresses in a niter bath operating at a temperature of 300 deg. cent. The cracking in this instance was probably accelerated by the corrosive acting of the fused nitrate at the working temperature. It was observed, however, that as similar steel tube which had been annealed below the critic range, and another which had been normalized, did not crack when exposed to the action of the fused salt. The evidence afforded by the instances mentioned is adduced in support of the theory that internal stresses are the main factor in bringing about failures in season cracking. It is believed that the most favorable conditions for the development of the phenomenon in the case of steel arise within a temperature range a little below 300 deg. cent. corrosion is considered as an after effect and not the primary cause of cracking. Failure can occur solely as the result of stresses either internal or external, to which the metal is subjected. (*Engineering*, vol. 111, no. 2885, April 15, 1921, pp. 467–469, 7 figs., *d*)

THE MECHANISM OF FAILURE OF METALS FROM INTERNAL STRESS

By W. H. Hatfield

A study of the influence of cold work and of chemical action on the failure of metals without the operation of deforming stresses. The possibility of the existence of the non-crystalline phase of metal either between the crystals or as a result of cold work, at temperatures ranging from the freezing point to the normal, has been postulated as a general working theory to explain such phenomena as season cracking in brass, smashing of castings from internal stress, the rupture of ingots, of hardened steel parts, etc. This theory is examined in the light of experimentally established facts. No direct evidence is found of the existence of an amorphous condition in metals. Arguing, however, from the results obtained in experiments on cold-worked and annealed brass, it is established that the amorphous phase, as compared with the crystalline, is considerably harder, and has a higher elastic range and a reduced capacity for plastic deformation. It is also experimentally determined that the amorphous phase cannot have sufficient mobility to allow viscous flow. The general conclusion is that except in certain cases where selective chemical or physico-chemical action causes a separation of the remains of crystals from each other, fractures such as those under discussion are due to internal stresses introduced during processes of manufacture. Such stresses may not be high enough, initially, to produce rupture, but rupture occurs when weaknesses introduced by chemical or other influences lead to increased local concentration of stress, or in some cases where changes in temperature in themselves lead to accentuation of the breaking stress. (*Engineering*, vol. 111, no. 2884, April 8, 1921, p. 435, *e*)

INTERNAL STRESSES IN RELATION TO MICROSTRUCTURE

By J. C. W. Humfrey

Study of the microstructure of metals and of the mechanism of their behavior under plastic deformation indicates that internal stresses between one crystal and another, due to a previous overstrain or thermal treatment, must play a large part in determining the subsequent mechanical properties. It is found that if a metal is overstrained in tension and allowed to "recover" its elasticity, then, in addition to the elastic limit in tension being raised, the corresponding elastic limit in compression is lowered; vice versa, if the elastic limit in compression is raised by overstrain in compression, then, at the same time, the elastic limit in tension is lowered. The two elastic limits appear in fact always to move in the same absolute direction together, metals possessing a certain elastic range, which, while it may vary in extent, yet reaches certain limiting values. In a bar built up of two materials possessing different mechanical properties, uniform straining will set up internal stresses which have the effect of producing a symmetry in the position of the elastic limits, similar to that which has been found in the actual experiments upon metals. It would appear reasonable, therefore, to deduce that the heterogeneous structure of metals was responsible for this particular phenomenon. In pure metals it is considered that the intercrystalline boundaries are the chief cause of heterogeneity of structure. Microscopic study of the effects of strain shows that the boundaries offer a definite barrier to the propagation of continuous slip between two crystals, and that each crystal in a mass of metal behaves as if it were enclosed in a thin but hard skin which can only deform by elastic bending. In alloys, and especially in the carbon steels, the heterogeneity is more evident, and it is obvious that no general deformation can take place without comparatively large stresses being left between the different crystals. A photomicrograph of severely strained pearlite shows that the cementile laminæ lying in the direction of the strain have been doubled up into wave forms. Internal stresses can also be set up in metals by virtue of the possession by the constituent parts of different coefficients of the thermal expansion. In steel, the coefficient of the ferrite is 10 per cent less than that of the pearlite, which might result in the ferrite being put into compression. (*Engineering*, vol. 111, no. 2884, April 8, 1921, pp. 419–420, 3 figs., *t*)

INTERNAL FRACTURES IN STEEL RAILS

By Henry S. Rawdon

A discussion of the type of defect known as "transverse fissure," which is sometimes found in the heads of American steel rails. Its prevalence in American rails is attributed to the difference in the service the rails have to withstand and the harder rail which is used as compared with European practice. The defect is internal and consists of a bright silvery mass enclosed within the normal metal and itself enclosing a nucleus of coarsely granular appearance. The microscope reveals a number of deep gashes or discontinuities, usually, though not always, approximately perpendicular to the axis of the head of the rail. These internal cracks have been found in rails before use, but are much more frequent in rails which have been in service. The general opinion is that transverse fissures represent the growth of internal defects which arise in the rail as a result of the severe cold-working of the tread and become larger and larger with the repetitions of stress developed in the rail in service. The fact that the appearance of the nucleus is identical with that of the face of internal fractures also strongly supports the view that the two are one and the same thing. This is in line with the well-known fact that fatigue breaks of all kinds originate most readily in the neighborhood of those defects which considerably modify the stress distribution. (*Engineering*, vol. 111, no. 2885, April 15, 1921, pp. 470–471, 2 figs., *g*)

INTERNAL STRESSES IN BRASS TUBES

By R. H. N. Vaudrey and W. E. Ballard

An investigation of a peculiar type of failure in some brass tubes of circular section containing 70 per cent of copper. The defect took the form of an apparent stratification of the wall of the tube, which was shown by the ordinary commercial test of expanding on a conical plug. The fracture usually showed at least two layers, the outer one being dark and tarnished, the inner one crystalline. "Hollow-sunk" tubes were first studied, that is, tubes drawn through a die without any form of internal support. A tube $1^3/_4$ in. in external diameter and $1^1/_2$ in. in internal diameter was annealed and hollow-sunk to an outside diameter of $1^{29}/_{64}$ in. A piece of the tube about 3 ft. 6 in. long was left on a table for four days and at the end of this period it had deformed 1/4 in. from the straight. Lengths of 2 in. of the tube, with multiples of 1/64 in. turned off the inside and outside, were immersed in an acid solution of mercurous nitrate and the times taken for the specimens to crack noted. Similar experiments were conducted on a tube drawn from the same original size, through a die of $1^{23}/_{64}$ in. bore, the inside being supported by a $1^1/_8$-in. diameter mandrel bar. It was concluded that in the "hollow-sunk" tube a thin layer on the outside of the wall was under high tension rapidly falling to zero, while a thin layer on the inside was under a high compression. In tubes manufactured without sink the internal stress passed uniformly from a maximum tension on the outside through zero to a maximum compression on the inside. The stratification of the specimens which occasioned the investigation was attributed to the tubes having been formed with too large a sink and too small a reduction in thickness, combined with the cracking action of the pickle bath. (*Engineering*, vol. 111, no. 2884, April 8, 1921, p. 421, 5 figs., *e*)

NOTES ON FRACTURES IN LOCOMOTIVE BOILER TUBES

By Sir Henry Fowler

A study of a peculiar brittleness that was found to have developed in the superheater tubes of a locomotive after it had run about 60,000 miles. Investigation showed that of the 21 large tubes, 8 had brittle ends, while 13 were fairly malleable. The tubes were lap-welded, and it was obvious that the steel-tube strip from which they were made was in both cases of poor quality. Microscopic examination showed that the impurities were largely concentrated in the boundaries between the crystals, and that the fractures were generally intercrystalline. The actual increase in the diameter of the tubes due to expansion was found to be only about 3.5 per cent of their original size. Tensile tests taken from the ends and middle

of the tubes disclosed the fact that in both the brittle and the malleable specimens the maximum stress was much greater and the elongation much less at the ends than at the middle. In bending tests the expanded portion of a brittle tube fractured at 10 deg., while pieces beyond the zone on which work had been put passed through an angle of 180 deg. without fracture. In some few cases the fractures showed laminated materials and signs of rust. In order to ascertain if the brittleness of the tubes was due to the original stresses set up in expanding, portions of two separate brittle tubes were taken from unaffected parts of the tube, made into rings and expanded in the usual way. The Brinell hardness was in one case increased from 111 to 156, and in the other from 131 to 143, but in neither case did the metal become brittle. No definite suggestion as to the causes of the brittleness and fractures is offered, but it is intimated that they might be due to the repeated stresses set up during the work of the locomotive acting on the material already in a state of stress, regard being had for the fact that the phosphorus content of the metal was 0.009 per cent. (*Engineering*, vol. 111, no. 2885, April 15, 1921, pp. 466–467, 11 figs., *e*)

Short Abstracts of the Month

AERONAUTICS

AIRCRAFT STATISTICS. The following preliminary statement of the general results of the 1920 census of manufactures with reference to aircraft has been issued by the Bureau of Census, Department of Commerce, and furnishes a detailed statement of the quantities and values of the different types of aircraft manufactured during the year 1919. It was prepared under the direction of Mr. Eugene F. Hartley, Chief Statistician for Manufactures.

Reports were received from 31 establishments engaged in the industry during 1919 showing products for the year valued at $14,372,643, as compared with 16 establishments in 1914 with products valued at $789,872. Of the 31 establishments reporting for the year 1919, ten were in New York; four in Ohio; two each in California, Massachusetts, and Missouri; and one each in Connecticut, Indiana, Illinois, Louisiana, Maryland, Nebraska, New Jersey, Pennsylvania, Rhode Island, Washington, and West Virginia.

The following is a summary of statistics of the industry for 1919, the "All other products" reports consisting chiefly of airplane parts, engines, and repair work:

Number of establishments	31
Total value of products	$14,372,643
Airplanes:	
Number	432
Value	$3,466,452
Seaplanes:	
Number	230
Value	$4,580,016
Value of work done during year on airplanes and seaplanes not completed	$1,658,670
All other products, including parts and repair work	$4,667,505

(*Department of Commerce, Bureau of Census, Preliminary Notice.*)

STRUTLESS-TYPE AEROPLANES, E. Meyer. Discussion of the elementary theory involved and description of some European types of strutless planes.

The main reason for the existence of the strutless plane lies in the desire to reduce the so-called parasite resistances, i.e., resistances to the motion of the plane which do not in any way contribute to its lift. Such resistances increase very rapidly with increase of speed, and call for correspondingly greater expenditures of power.

Of the planes described the Junkers is well known in this country. Of the other planes may be mentioned the Siemens-Schuckert monoplane, the Fokker monoplane, the Sablatnig machine, and a very interesting monoplane hydroaeroplane of all-metal construction, built by the Zeppelin Works in Lindau and known as the Dornier. No detailed data are given as to any of these machines except the general dimensions and rated power of the engines, and in the case of the Zeppelin plane not even these are given. (*Schweizerische Bauzeitung*, vol. 77, no. 15, Apr. 9, 1921, pp. 166–168, 7 figs., *d*)

BUREAU OF STANDARDS (See Engineering Materials)

ENGINEERING MATERIALS

THE SPRENGER PROCESS OF MAKING CONCRETE, E. Weiss. In this process a machine is used which its inventor calls the Aero-Malaxeur. In this machine wet sand and gravel are projected through an atmosphere saturated with the binding material, which may be blown in a state of complete pulverization by some kind of a blower.

The machine essentially consists of a slightly inclined mixing drum rotatable in its bearings. In the top part of the drum there is a hopper for storing the sand and gravel, into which there is discharged at a predetermined rate water to give the materials the desired degree of moisture. At the other end of the cylinder there is a double proportioning hopper containing the binding elements, such as lime, cement, or a mixture of the two. The graduated orifices admit these materials into the cylinder in a strictly predetermined proportion and a strong blast of air coming from a blower

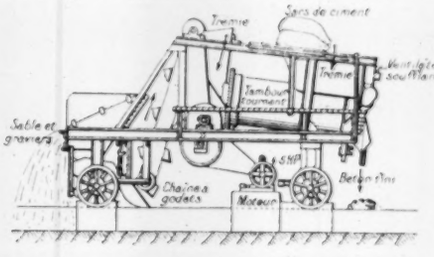


FIG. 1 DIAGRAMMATIC VIEW OF THE SPRENGER AERO-MALAXEUR CONCRETE-MAKING MACHINE

Sable et graviers = Sand and gravel; *Trémie* = Hopper; *Sacs de ciment* = Cement sacks; *Tambour Tournant* = Rotating Drum; *Ventilateur soufflant* = Blower; *Béton fini* = Finished concrete, *Moteur* = Motor; *Chaine à godets* = Roller chain

carries them to meet the materials coming from the other end of the drum. As each grain of sand or gravel is projected from the upper hopper into the cylinder where it moves in an atmosphere filled with the binder, it becomes therefore completely and intimately blended with the latter.

The machine is of the continuous-operation type and is entirely automatic, the concrete arriving at the bottom of the cylinder being discharged into cars or bins. It is claimed that with this machine the lack of uniformity of sand or gravel is less important than in the production of concrete by other means. (*La Nature*, no. 2444, Feb. 5, 1921, pp. 95–96, 4 figs., *d*)

SOME PROPERTIES OF WHITE-METAL BEARING ALLOYS AT ELEVATED TEMPERATURES, John R. Freeman, Jr. and R. W. Woodward. The Bureau of Standards as part of a general investigation of the properties and methods of testing the white-metal bearing alloys has developed apparatus for determining their properties at elevated temperatures. This paper describes apparatus for determining the yield point and ultimate strength of these alloys in compression at temperatures up to 150 deg. cent. A similar apparatus is also described for determining the Brinell hardness at these elevated temperatures.

The results of compression tests and Brinell hardness tests obtained with this apparatus at 25 deg. cent., 50 deg. cent., 75 deg. cent., and 100 deg. cent. are given for the five following alloys:

Alloy No.	1	2	3	4	5
	Per Cent				
Copper	4.56	3.51	5.65	2.90	
Antimony	4.52	7.57	6.90	10.50	10.03
Tin	90.02	88.92	87.36	61.55	5.02
Lead	absent	absent	0.09	25.05	84.95
Iron	0.05	0.05	0.05	0.05	0.05

Alloys Nos. 1, 3, 4, and 5 are the four alloys being recommended by the S.A.E. as standard alloys.

The results of these tests show that the three tin-base alloys maintain their properties better at the elevated temperatures than either the lead-base or the intermediate alloys.

The effect of the addition of up to 5 per cent of lead on the properties of the tin-base alloys was studied and found not to influence the yield point at 25 deg. cent. or 75 deg. cent.

The yield point of the tin-base alloys is not affected by heating for six weeks at about 100 deg. cent., but the yield point is lowered in the lead-base by heating for two weeks at about 100 deg. cent. (*Abstract of Technologic Paper of the Bureau of Standards*, no. 188, *g*)

INFLUENCE OF NICKEL ON CAST IRON. Buner and Piwowarsk have carried out a series of tests to determine the influence of nickel on cast iron, using Swedish charcoal iron with a total carbon content of 3.90 per cent, of which 2.80 per cent was graphitic carbon, a silicon content of 0.69 per cent, and a manganese content of 0.18 per cent. It was found that this metal readily formed an alloy with 1.2 to 3 per cent of nickel at a temperature only 50 deg. cent. higher than the melting temperature of cast iron.

Mechanical tests have shown that the best results are obtained with an alloy containing 1 per cent of nickel, the transverse strength being increased 30 per cent, the compressive strength 30 per cent, and the tensile strength 25 per cent, while the hardness is increased only 18 per cent. The addition of 1½ per cent of nickel conferred no advantage whatever, the influence of the nickel on the separation of graphite more than counterbalancing the favorable effect on ferrite. (It is not quite clear whether by this is meant that an addition of 1½ per cent of nickel gave no advantage as compared with an addition of 1 per cent, or that the comparison is made with nickel-free cast iron.)

For the manufacture of high-tensile cast iron for machine parts, gear blanks, etc., cast iron containing 1.2 per cent of nickel is recommended.

It is of interest to note that cobalt, which usually has an effect very similar to that of nickel, in this case acted in quite the reverse manner, reducing the resistance to bending, tensile and compression strengths, while increasing the hardness. This is due to the fact that cobalt retards the separation of the graphite and favors the formation of carbides. (*Stahl und Eisen*. Abstracted through *Automotive Industries*, vol. 44, no. 13, Mar. 31, 1921, p. 705, *e*)

MATERIALS FOR TURBINE BLADES, P. Bardenheuer. In rolled and drawn materials for steam-turbine blades there are often stresses set up during the process of manufacture which are equalized only after the apparatus has been in use for some time. The equalization of these stresses results in permanent changes of shape and contraction of turbine parts which may more or less endanger the safety of operation of the machine.

In order to obtain reliable data as to the the magnitude of elongations in turbine blades due to the above-described causes, Gustav Wallenborn, in a thesis presented in 1916 in Darmstadt (probably at the local polytechnic institute) investigated several materials such as nickel steels, carbon steels, and the more common copper alloys, including monel metal. In the course of these tests he determined the coefficient of heat expansion and permanent elongation after tenfold heating to 350 deg. cent. (662 deg. fahr.) and also the specific weight, hardness, and tensile strength of the samples of their original state and after such heat treatment.

The test pieces were used in the form of rolled or drawn bars as well as in the final machine form of blades, the bars having either round or rectangular shapes. The cross-sections of the test pieces differed very materially. The chemical composition was not determined and exact information as to the manufacture of the test pieces before they reached the investigator was not available, which deprives the investigation of much of its scientific value.

Of the data collected the most important are presented in Table 1. Of particular interest is the expansion due to heating and the permanent elongation of the test pieces.

As regards the elongation, the author of the thesis states that it appears to depend exclusively on the molecular stresses in the material. If the material has merely been rolled, permanent elongations appear; but if it is then subjected to cold drawing, the permanent elongations gradually disappear, until after a certain number of passes a permanent contraction sets in. The correctness of this statement, however, may be questioned. (*Stahl und Eisen*., vol. 41, no. 6, Feb. 10, 1921, p. 204, *e*)

TABLE 1 EXPANSION AND PERMANENT ELONGATION OF TURBINE BLADE MATERIALS

Material	Expansion due to heating for 100 deg. cent. in mm. per meter length of bar		Permanent elongation in mm. per meter length of bar	
	Average Values	Minimum and Maximum Values	Average Values	Minimum and Maximum Values
5 per cent nickel steel	1.017	0.97–1.14	+0.21	—0.02 –+0.641
25 per cent nickel steel	1.66	1.54–1.72	+0.012	—0.120–+0.060
30 per cent nickel steel	1.28	1.26–1.30	0.00	—0.02 –+0.02
36 per cent nickel steel	0.063	.....	+0.018	.....
40 per cent nickel steel	1.10	.....	+0.22	.....
Cast steel	1.07	0.98–1.13	+0.11	—0.04 –+0.22
Monel metal	1.37	1.31–1.47	—0.04	.....
Aluminum bronze	1.55	1.54–1.56	—0.08	0.18 –+0.13
Delta bronze	1.82	.....	+0.25	.....
Phosphor bronze	1.65	1.64–1.65	0.21	.....
Bronze	1.72	1.65–1.83	+0.017	—0.07 –+0.16
Brass	1.72	1.59–1.76	+0.015	—0.45 –+0.145

FOUNDRY

CENTRIFUGAL CASTINGS. Description of the methods used at the works of Stokes Castings, Ltd., Mansfield, England, where a regular output of centrifugally made castings is now being obtained, the average output for the last few months being in the neighborhood of 2000 castings per week.

The castings produced are, in the main, for internal-combustion engine work—piston-ring drums and engine liners—and it is said that perfectly satisfactory machining qualities are being obtained without any annealing or heat treatment. This result has been obtained as an outcome of an excessive series of experiments on mixtures, pouring temperatures, die temperatures, speeds, etc., each of these variants being a determining factor in the quality of the resulting material.

The quality of the product obtained is said to be markedly superior to material cast in sand molds or stationary chills. Graphite plates are practically eliminated.

The casting plant consists of a number of machines. In the latest type the machine is driven direct by means of a variable-speed motor through a flexible coupling and friction clutch. The time taken to produce a 6-in. diameter drum is something under a minute, counting from the time of pouring into the receiver on the machine to time of taking out the completed castings.

Up to the present most of the research has been devoted to the question of gray cast iron, but interesting experiments have been made with some of the non-ferrous metals. The comparison of microsections of lead-bronze castings made in ingots and centrifugally, shows that in the latter casting the grain is very much smaller, indeed about 1/150 the size of the ingot crystal. The chemical analysis of the material shows that the lead and tin have tended to fly to the outside of the casting, which is reflected in the fact that the Brinell hardness near the bore is 101 and near the outside 90.0. (*Engineering*, vol. 111, no. 2881, Mar. 18, 1921, pp. 311–312, 6 figs., *d*)

FUELS AND FIRING

Novel Type of Oscillating Grate

TWO-STAGE COMBUSTION IN THE "EVAPORATOR" STEPPED OSCILLATING GRATE. The stepped oscillating grate has come into prominence on the market in the last few years because of its advantages for the combustion of friable, dirty and powdery fuels. These advantages consist in the comparatively large free grate area which can be easily obtained with a stepped grate and the ease with which the dropping of fuel through the grate can be prevented. This makes the stepped grate particularly suitable for such fuels as lignite, breeze, etc.

The conditions of combustion in the case of a stepped grate are also said to favor the employment of the poor grades of fuel.

In order, however, to utilize all fuels at a higher efficiency a two-stage combustion may have to be considered, as has already been done in the new stepped grate developed by the German Evaporator Company.

Fig. 2 shows the general arrangement of the new grate. The amount of fuel supplied from a hopper on to the main stepped grate *d* is regulated by the usual gate *a*. In addition to this, there is in the hopper a throttling device *b*, the position of which can be shifted by a gear drive. The hopper *c* under the throttle *b* is equipped with airtight gates, which are used for starting the fire on

the grate and to permit seeing what is going on on the grate by withdrawing the throttle *b*.

The stepped grate itself extends into the body of the coal-supply hopper so that the mechanical introduction of fresh coal on the grate begins directly under the fuel-regulating gate *a*. This gives the coal in the hopper a slight motion and makes a constant and regular supply of coal to the grate more certain. The main grate consists of a series of perforated overlapping plates located stepwise and held by the grate-bar shoes. These latter have their bearing in the grate frame which permits a certain freedom of oscillation to the grate plates and this, in its turn, enables the spaces between the grate plates to be made smaller or greater; furthermore it permits the grate plates to be swung into a position inclined at such

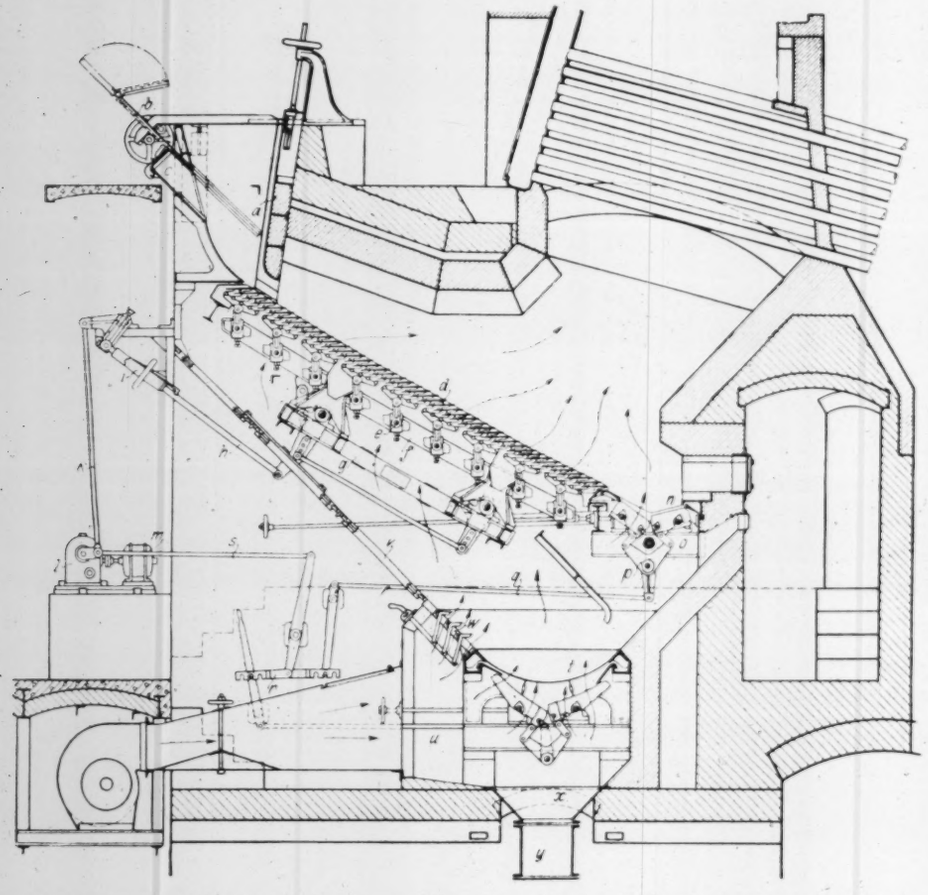


Fig. 2 Stepped Oscillating Grate with Two-Stage Combustion Built by the German Evaporator Company

an angle as to sweep away the residues of the foundation fire, which is of practical importance in connection with the burning of sandy fuels, such as certain kinds of lignites. The grate-plate shoes with their lever-shaped ends, usually in groups of five, are connected to a lever with link action *e*, by means of which and the rod *f* they can be shifted into the desired position. The rod *f*, in its turn, is connected with the speed-change gear *l* driven by a motor *m*, the lever rods *g*, *h*, *i*, and *k* serving to transmit the motion from *l* to *f*. By shifting the rod *f*, the grate plates can be adjusted so as to make the interstices between them either large or small. The movement of the grate plates themselves is regulated from the speed-gear shift on the motor and must be suitably adjusted for the fuel burned, so as not to distribute the foundation fire and make certain the ignition of fresh fuel.

The residues of combustion from the main grate *d* are taken up by the intermediary grate *n*, which acts also as a clinkering grate and as a kind of sluice for transferring the residues on to the end grate *t*. The intermediary grate consists of oscillating grate members *o* swinging in opposite directions and thereby breaking up the residues of combustion from the main grate.

From the grate *n* the residues of combustion travel down an incline to the end grate *t* which is built in the same way as the intermediary grate *n*, located in an air chamber *u* and supplied by air from a blower. This air chamber is located tight against the wall *v* of the main grate and is provided with a number of outlets *w* closed by shutters, the openings in which can be regulated. It is from this chamber that the undergrate blast is supplied to the main grate, so that the blast is partly under the main grate and partly under the end grate *t*, where it helps to burn up all the fuel residues.

It is claimed that the resulting gases of combustion together with the excess of blast highly superheated on its way, ascend upward to the main grate and materially assist in the combustion. The ashes and clinkers from the end grate go into the ash pit *x* and are discharged into the ash cars through *y*. (*Zeitschrift fur Dampfkessel und Maschinenbetrieb*, vol. 43, no. 53, Dec. 31, 1920, pp. 405–407, 3 figs., *d*)

Properties and Characteristics of Colloidal Fuel. Linden W. Bates and Haylett O'Neill. It is stated that a colloidal fuel is composed of from 0 to 40 per cent of carboniferous material (coal, coke, charcoal, lignite, peat, hard pitch, or any similar grindable material) mixed with fuel oil and held in suspension with about 1 per cent of fixateur (no information given as to this latter). Data are given for determining the specific gravity and heating value of various colloidal fuels. (Paper read before the Royal Society of Arts, London. Abstracted through *Power Plant Engineering*, vol. 25, no. 7, April 1921, pp. 368–369, 2 figs., *g*)

INTERNAL-COMBUSTION ENGINES (See also Thermodynamics)

Fuel and Air Regulation in Heavy-Oil Engines

Device for Automatically Regulating the Supply of Fuel and Injection Air in Heavy-Oil Engines, Max Lindemann. With the usual Diesel-engine injection valves the conditions are such that if the air pressure and valve design are adjusted properly to take care of full-load conditions too much air is used at half load, which makes the mixture excessively lean, and if the load is reduced still further the engine may cease to fire.

This could be obviated by reducing the amount of injection air at part load, but it isdifficult to accomplish it in actual practice, because if the load varies suddenly the variation in the amount of injection air cannot follow it fast enough.

One way to obviate this is to govern the engine by varying the lift of the valve needle. By this method a practically constant composition of mixture may be maintained at all loads and the combustion conditions made more uniform and certain. This method of governing is, however, complicated and cannot be applied to all kinds of engines.

Fig. 3 illustrates a device said to have been developed by the Leobersdorf Machine Company. Here a valve disk *N* sliding on the valve stem of the fuel valve *M* is held by a spring against the lower surface of the cylindrical piece *P* fixed in the valve housing. In *P* a passage *A* reaches to the top of the piece, into which the fuel flows through another passage *T* in amounts proportional to the load. An air passage *B* is also located in *P*. The passages *A* and *B* both open into the lower face of the piece *P* and are closed off by the same automatic valve *N*.

The device operates in the following manner: The fuel introduced into the passage *A* in accordance with the load on the engine

is held therein by the valve disk N. When valve M is opened, however, N is forced away from P by the injection-air pressure, and fuel and injection air flow respectively from passages A and B. As the same constant injection pressure obtains in both passages, there is discharged from each of them an amount of fuel or air proportional to the time during which the passages are held open. Hence, once the cross-sections of the two passages have been placed in a constant relation to each other, the ratio of fuel to injection air will also have to be constant. If all of the fuel from passage A has been discharged, the remaining injection air will flow into it.

As a result of this arrangement, from the very beginning of the opening of the fuel valve a constant mixture of fuel and injection air is admitted, and this admission lasts until a sufficient amount is discharged to correspond with a given load on the engine. From then on and up to the time that the fuel valve is closed, only injection air flows into the working cylinder. Fig. 4 gives diagrammatically the proportioning of the fuel from one-quarter up to full load. In this figure the base line indicates the path of the opening of the fuel valve. The sectioned areas correspond to the injected mixture of fuel and air, while the white areas show the amount of air flowing after the flow of the fuel mixture has been cut off.

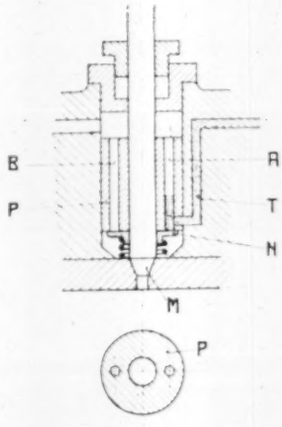


FIG. 3 DIESEL-ENGINE FUEL-INJECTION VALVE OF THE LEOBERSDORF MACHINE CO. (GERMANY)

In all such constructions the following two conditions must be observed:

(1) The passages for the reserve of fuel and for the injection of air must be arranged in such a manner that their cross-sectional areas which are in constant relation to each other give a constant mixture ratio of fuel and air all at loads until the entire fuel (in the reserve passage) has been used up.

(2) The passages which are closed by a common automatic valve or similar device must be so arranged that from the beginning of the flow of injection air both fuel and air are discharged; that is, from the beginning of the air-injection period a constant mixture ratio is available.

In the test carried out by the author a two-cylinder Dissel engine developing 110 hp. at 190 r.p.m. was equipped with the device shown in Fig. 5. Here a helical passage A has been provided for the fuel and from it small holes lead to the seat of the valve B. Further, six passages C are provided for the injection air in order to make it possible to vary the mixture ratio by opening and closing some of these passages.

The test engine has purposely been equipped with a very light flywheel, so that the coefficient of fluctuation has been computed to be 1/38. This was done in order to make it possible to observe the regularity and reliability of ignition from the tachogram.

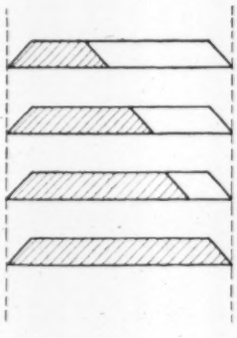


FIG. 4 RELATIVE FUEL AND AIR PROPORTIONS FOR VARIOUS LOADS WITH THE VALVE OF FIG. 3

The first effort to start the motor failed. Heavy white clouds of crude-oil vapor came out of the exhaust, but the mixture did not ignite. The passages C were closed one after another by the insertion of conical rods. When two of these passages were closed the engine started to run, but it soon became apparent that the cross-sections of the air passages as compared with the cross-sections of the fuel passages were still excessive. A third air passage was then closed and the cross-section of the fuel passage enlarged by boring it out. It was only then that the correct ratio of cross-section was obtained, and the motor, even when cold and at a lower speed, began to work reliably and regularly at all injection-air pressures. The original paper shows the card covering the operation of the motor from 25 per cent overload down to no load with the injection air at 60 atmos. pressure.

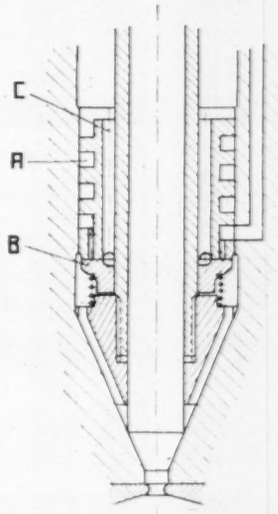


FIG. 5 VALVE USED ON AN EXPERIMENTAL TWO-CYLINDER DIESEL ENGINE (SAME PRINCIPLE AS FIG. 3)

After a number of tests the motor was connected to an electric generator acting as a brake. In these tests it was found that with the full injection-air pressure the load may be varied within wide limits without bringing about failure of injection and prolonged variations in speed. It was found that the difference in pressure in the injection air between prolonged operation at normal load and prolonged operation at no load amounted to only 2 atmos. (65 down to 63 atmos.). It would appear, therefore, that the load may be varied within wide limits without any regulation on the compressor. It would further appear that the valves remain in good condition after fairly prolonged operation of the motor, (*Oel-und Gasmaschine*, vol. 18, no. 1. Jan. 1921, pp. 1–5, 13 figs., *de*)

PALM-OIL ENGINE FUEL. At a recent meeting of the Association for the Improvement of Colonial Materials, Major Trentals of the Belgian Colonial Army described developments in the use of palm oil and other vegetable oils grown in the Belgian Congo in internal-combustion engines.

The tests were carried out on a stationary two-cycle semi-Diesel engine developing 8 to 10 hp. at 500 r.p.m. The palm oil employed was of medium or low quality, containing considerable amounts of free fatty acids and impurities. The only really special feature on the engine was an arrangement made for keeping the palm oil in a sufficiently liquid condition. For this purpose the cylinder-cooling water was used and together with the hot exhaust gases maintained the oil in the feed tank at a temperature high enough to insure liquidity, and at the same time evaporate any water which might be present. In addition to this a gasoline vapor lamp was placed under the tank.

The feed tank consists of a series of compartments divided from each other by fine-mesh metal screens to filter the oil before admitting it to the injection pump.

The engine starts on gasoline and finishes on gasoline in order to remove any residual palm oil from the feed pipes, which might get clogged by the congelation of the oil when the engine is at rest. [The average melting point of oil is about 37 deg. cent. (99 deg. fahr.) which varies with purity and origin.]

A certain amount of water is injected into the cylinder. The palm oil referred to in this paper is obtained from the fleshy pericarp of the palm fruit and is not the palm-kernel oil contained in the palm nut. Palm-kernel oil does not differ much in heat value from peanut oil. (Paper before the Association pour le Perfectionnement du Matériél Colonial. Abstracted through *Gas and Oil Power*, vol. 16, no. 186, Mar. 3, 1921, pp. 85–86, *e*)

MACHINE PARTS (See Machine Shop)

MACHINE SHOP

Maag System of Gearing and Gear Cutting

THE MAAG SYSTEM OF GEARING. The Maag system of gearing has been developed by Max Maag, of the Maag Gear Wheel Company, Zurich, Switzerland.

The gear-cutting machine employed is a modification of the Sunderland gear planer made in England. The wheel blank in the Maag machine, however, is mounted on a vertical axis so that the cutting movement of the rack is vertical, which is said to in-

crease rigidity and enable the tool to take heavy cuts. Also, in order to eliminate the effect of the backlash in the screw communicating the rectilinear component of the rolling motion to the work, an arrangement has been introduced consisting of a second and more quickly threaded screw and nut and a friction drive, whereby the cross-slide during the generating movement is maintained in uniform contact with the flanks of the main pitch screw. The actual movement of the slide is therefore effected by the subsidiary screw, while the main screw is relieved of all duties except the regulation of the movements. It is claimed that this makes the motion truly uniform and results in a complete absence of play.

There is also an interesting arrangement for balancing the cutter ram.

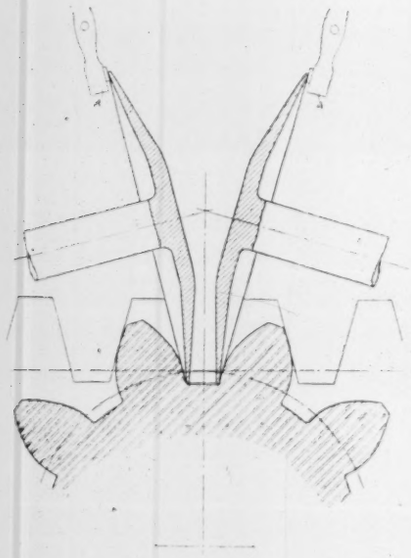


Fig. 6. Diagram Showing the Maag Method of Grinding Gear Wheels

One of the features of the Maag system is that the wheels can be formed of a mild or nickel steel and case-hardened and ground after being cut. The object of grinding the wheels is not only to produce a good surface on the hardened teeth, but to remove the distortion almost inevitably caused by the hardening process.

In the Maag generating grinding machine the grinding is performed (Fig. 6) by means of two saucer wheels set apart and inclined in such a way that the planes of the saucer lips would coincide if superimposed with the flanks of one tooth of the rack cutter used in the preceding process. The gear wheel to be ground is mounted on a longitudinal axis and is fed longitudinally beneath the rotating grinding wheels. As it passes beneath the grinding wheels the gear wheel is reciprocated transversely through a small distance and at the same time is rocked through a corresponding angle, the two movements being correlated so as exactly to reproduce the movement of the gear wheel if it were rolled, without slipping, on its pitch circle. True rack-and-pinion action is thus secured as in the preceding cutting machine, but in this case the work has to be indexed relatively to the grinding wheels once for every tooth gap, as the "rack" has but one "tooth."

The most interesting feature of the machine is the means adopted for compensating the wear of the grinding wheel which would reduce the width of tooth of the imaginary rack cutter, and therefore progressively to increase the width of the teeth being ground. The wear can, however, be compensated by moving the grinding wheels apart, each parallel with itself.

The compensating mechanism consists of an electrically controlled mechanical device. Associated with each grinding wheel is a camshaft driven continuously at about ten revolutions per minute by belt and gearing from the motor driving the grinding-wheel spindle. At each revolution the camshaft causes the lever *A*, Fig. 6, to oscillate on its pin and to advance, toward the grinding wheel edge, a diamond carried at its lower end. If the movement of the lever is checked by the grinding-wheel edge at the correct point nothing happens. If, however, the wear of the grinding wheel exceeds a certain amount the lever, before its movement is checked, will swing sufficiently far to establish an electrical contact. The current which then flows is relayed to operate a clutch on a continuously driven shaft from which, when the clutch is active motion is transmitted through a pawl and ratchet wheel to a differential thread and thence to an adjusting screw on the grinding spindle bracket. The bracket is thus moved until the plane of the grinding-wheel lip is restored to the correct position. The arrangement it is stated, is sufficiently sensitive to keep the wheels in the correct position to within one-thousandth of a millimeter. In addition, the compensating movement is said to be so trustworthy in action that it can be relied upon to correct the wear of the softest grinding wheel. It thus permits wheels to be used which, although they wear rapidly, are recommended from the point of view of cutting efficiency in preference to wheels of much greater hardness.

Arrangements are also made to secure the correctness of the rolling motion of the work.

An interesting gear-testing machine used by the same company is described. (*The Engineer*, vol. 131, no. 3403, Mar. 18, 1921, pp. 283–285, 5 figs., *d*. Compare *Machinery* (London), vol. 17, no. 437, Feb. 10, 1921, p. 575 *d*)

MARINE ENGINEERING (See Shipbuilding)

MOTOR-CAR ENGINEERING

Steam Car with Engine on Rear Axle

Coats Steam Car. Description of a new steam car being built at Indianapolis, Ind., and involving several apparently novel details.

In particular, the engine is located in the rear axle and the engine axle and differential function all in one, the engine itself in its housing being just about the size of the ordinary rear-axle gear case.

The housing of each half of the axle carries three fixed cylinders set at 120 deg. apart. These cylinders are exactly like those of the internal-combustion automobile engine with poppet valves, pistons and connecting rods. The bore is 2 3/4 in. and the stroke 3 in. The three connecting rods in each half of the axle are pivoted to a crankpin integral with the drive shaft of each wheel. At a speed of 40 m.p.h. the engine is running at about 500 r.p.m.

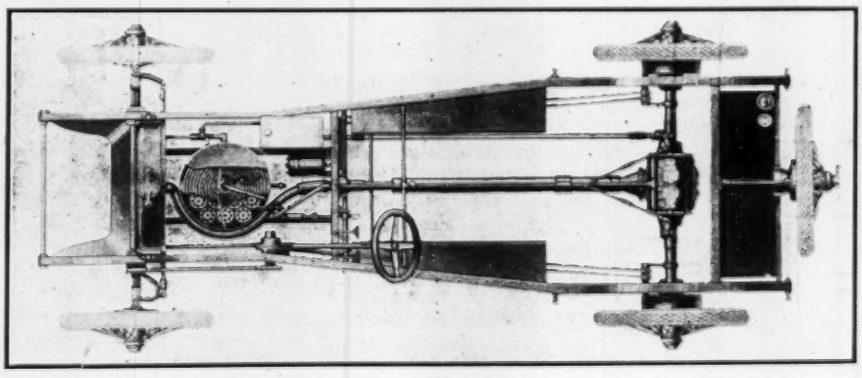


Fig. 7 General Arrangement of Coats Steam Car

The exhaust steam is taken by return pipe to the condenser located in front of the boiler in the position of the ordinary radiator.

The whole engine has therefore six cylinders and the general arrangement is shown in Fig. 7. The car for five passengers completely equipped weighs less than 1800 lb. and has less than 40

moving parts. It has no carburetor or ignition accessories, no clutch, gear shift, flywheel, propeller shaft, universal joints or differential; and uses kerosene as fuel, on which it is claimed to operate very economically.

It is stated that the design was worked out primarily by a Norwegian engineer, but developed to its present state of refinement in America. (*The Accessory and Garage Journal*, vol. 10, no. 11, Mar. 1921, pp. 88–89, 2 figs., *d*A)

MUNITIONS

A New Firearm: The Submachine Gun

SUBMACHINE GUNS, A. B. Richeson. The submachine gun is a new-comer in the world of firearms. It is really a machine gun reduced to the form and dimensions of a large pistol and is capable of delivering a stream of several hundred shots per minute, firing the 0.45 caliber Army automatic-pistol cartridge.

Three new mechanical principles have been necessary to produce the extreme lightness and simplicity of the new weapon combined with its sturdiness and reliability of functioning. They are the wedge lock, the oiling device, and the new disk magazine feed.

In the breech lock a small wedge weighing a few ounces takes the place of the usual recoil mechanisms. In working with a simple wedge type of breech closure it has been found that the smaller the inclination of the surfaces of the wedge, the smaller the pressure at which adhesion ceases, and, of course, as long as the surfaces adhere they resist any sliding upon each other.

The experiments have further shown that the breech opened when the wedge angle was considerably below the angle of repose, when friction might have been expected to hold the block after the adhesion ceased; and further, with the larger wedge angles considerable pressure in the bore still compressed the wedge between the cartridge case and the wedge housing with considerable force. The explanation of these two phenomena apparently lies in vibrations set up in the mechanism by the rapidly varying bore pressure.

In the rifle mechanism as developed, sufficient pressure remained in the bore when the wedge opened, for the empty cartridge case to be blown to the rear, carrying the bolt (containing the firing pin and firing spring) before it, with sufficient velocity to cock the firing pin when the bolt brought up against the rear buffer, and causing the empty cartridge case to rebound and to be ejected to the front. This movement of the bolt to the rear was against the force of compression of a spring designed to reload the piece.

In investigating the operation of a machine gun viewed essentially as a gas engine, it was found that the friction between the cartridge case and the walls of the firing chamber varied during extraction and at times was excessive due to residual pressure of powder gas within the cartridge case. This variable friction is attributed to different degrees of annealing the cartridge cases during manufacture and to tolerances in diametrical or longitudinal dimensions required in the commercial manufacture of cartridges. The important result, however, is that the ejection of the various empty cases takes place at different pressures and therefore does not occur at regular intervals or with equal ease and rapidity.

To obviate this an oiling device was built in, consisting of felt pads in the breech. Enclosed and protected against dirt, the pads are impregnated with lubricant by an ordinary squirt oil can, and each rearward movement of the bolt lubricates the mechanism afresh. Experiments have shown that it is not necessary to coat a cartridge case with oil to eliminate the friction difficulty in extraction, a very slight smear of lubricant answering the purpose satisfactorily.

The magazine feed is of the disk type, interesting because friction, which has been the great stumbling block in this type of feed, has been largely eliminated by a method of moving cartridges by means of a spiral spring that can be wound with the magazine either loaded or empty. In Fig. 8 the magazine device is, however, not fully illustrated.

The submachine gun is made without shoulder stock or sights, for ordinary rapid fire from the hip, but can be provided with stocks and sights if desired. It fires full-automatically as long as the trigger is held back, but single shots can be fired by quick release of the trigger after each shot. The gun seems to have good ballistic properties. (*Army Ordnance*, vol. 1, no. 3, Nov.-Dec. 1920, pp. 134–136, 2 figs., *d*A)

POWER PLANTS (See also Refrigeration)

Design and Testing of Water-Cooling Towers

WATER-COOLING TOWERS, I. V. Robinson. Description of the types of coolers and methods of testing. The article is the first of two on this subject.

Water-cooling towers are extensively used in Great Britain in connection with the largest central stations where the plant has outgrown the natural supply of circulating water and has to supplement it by artificial means.

Water-cooling apparatus differs considerably in type, but the principle and method of cooling is the same in all types, i.e., bringing into intimate contact with the hot water a large quantity of air at a lower temperature.

The coolers are classified as follows:

1 Chimney type:
  a Natural draft
  b Forced draft
2 Open type
3 Spray type.

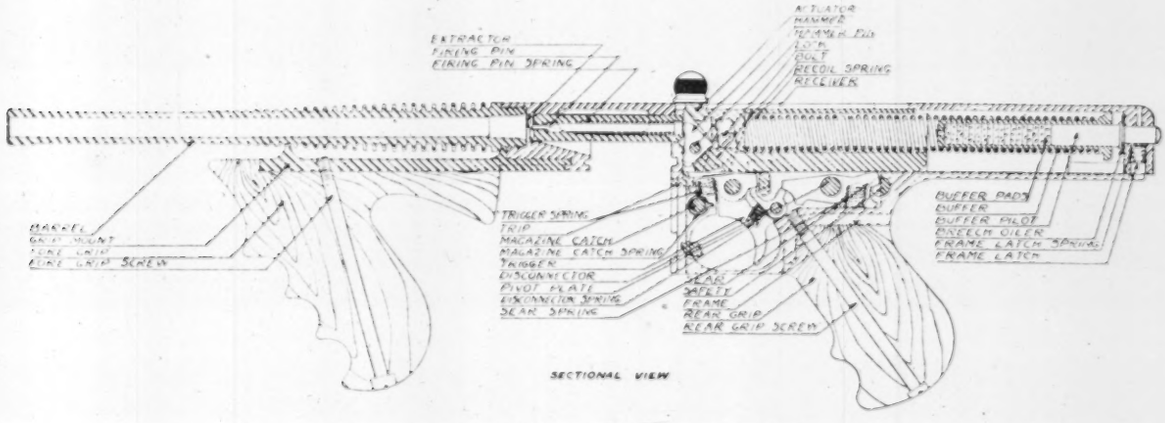


FIG. 8 SECTIONAL VIEW OF THE SUBMACHINE GUN

In a cooling tower heat is absorbed from the water by the air through two distinct actions: (*a*) Direct heating of the air, and (*b*) evaporation of a portion of the water.

Under the usual working conditions in Great Britain the heat absorbed by evaporation is about 75 per cent of the total heat absorbed, as shown by a brief calculation in the original article.

Natural-draft chimney-type cooling towers are most generally used. The water is admitted at a height varying from 16 ft. to

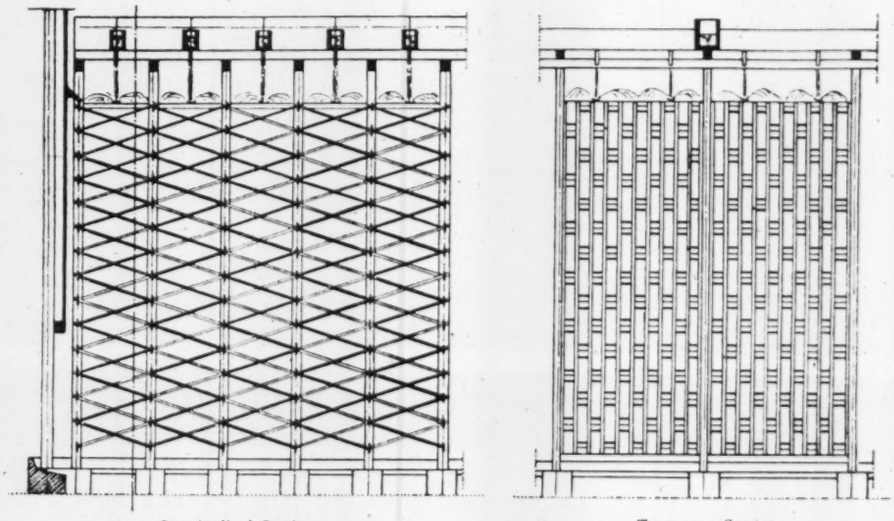
25 ft. above the sill level and is distributed over the whole area of the tower by main distribution troughs. From these troughs it falls into smaller troughs pitched closer than the larger distribution troughs and is allowed to fall on to the cooling stack by various special methods differing with various makers. Air is admitted usually around the whole perimeter of the tower at the base of the stack, openings about 5 ft. to 6 ft. high being left for this purpose. The various designs differ mainly in the methods used for initially distributing the water over the cooling stack and bringing the water and air into intimate contact.

Some concerns employ cast-iron or porcelain pipes and allow the water to fall into porcelain disks. If the height of fall of the water and the shape of disk are correctly chosen, the water will be broken into a fine spray.

Another method is to use dipper bars let into the side of the main distribution troughs. These bars have concave surface along which the water flows, overflowing then on to the cooling stack. The object in all cases is to divide the water so that it presents a large surface to the air and yet at the same time to allow the air to ascend the tower freely.

It is because of this second condition that the splash system has not found much favor with designers lately.

Fig. 9 shows a section though a cooling stack which depends upon film and not splash. After rebounding from the splasher disks under the small troughs, the water falls on to a number of inclined laths and flows down them. At the lower end of each lath there is a V-notch through which the water passes and then falls on to the upper end of the next inclined lath, and so repeats the process till the bottom is reached. In the stack illustrated the water flows over fourteen inclined laths, seven sloping in one direction and seven in the reverse direction. Each vertical set of laths is comparatively narrow and the sets are so arranged that adjacent laths at any level are inclined in the opposite direction. This alternate arrangement allows a free passage for the air up the stack, the air having to move horizontally only the width of one lath when passing each lath.



Longitudinal Section. Transverse Section

FIG. 9 DIAGRAMMATIC ARRANGEMENT OF COOLING STACK OF FILM-COOLING TYPE

Towers are usually built over a tank varying in depth up to 6 ft., and the concrete forming the tank has an important bearing upon the stability of the tower. Many local authorities in England stipulate that a structure such as a natural-draft cooling tower shall be able to withstand a wind pressure of 30 lb. per sq. ft., and do not consider that this condition is met unless the resultant of the horizontal wind pressure and the weight of the tower and the concrete tank to which it is securely attached, passes through the middle third of the base. The original article shows how these magnitudes are computed.

The author presents some facts, however, which would indicate that this regulation is excessively stringent, and believes that there would probably be an ample margin of safety if the resultant of the wind pressure and weight of tower and tank passed through the middle half of the base with the tank empty, as the effect of the water which is usually in the tank would be to bring the resultant into the middle third. As regards the testing of cooling towers, it is necessary first to determine clearly the object of the test. Manufacturers usually guarantee that when the tower is dealing with a stated quantity of water per hour at a given temperature, it will reduce the temperature by a definite amount under specified atmospheric conditions; and if the object of the test is merely to ascertain whether or not this guarantee of performance has been maintained, the test is quite simple and very few tests on cooling towers pretend to do more than this. But if it is desired to test the tower completely so as to learn whether any improvement can be made, a much more detailed test becomes necessary, a matter which is briefly discussed in the original article. [*Beama* (A monthly journal devoted to the interests of British electrical and allied engineering), vol. 8, no. 3, Mar. 1921, pp. 227–234, 5 figs., *dp*]

Design of Spray Ponds

SPRAY PONDS, Terrell Croft Engineering Co. Discussion of the design and description of several arrangements of spray ponds and nozzles used for recooling condensing water.

Two types of spray nozzles are shown in Figs. 10 and 11. The purpose of these nozzles is to break up the water into a fine mist, and the nozzles are set either vertically or at an angle—usually 60 deg.—with the horizontal.

It has been demonstrated experimentally (Fig. 12) that, first, recooling is more affected by the air temperature and humidity than by the temperature of the water coming from the condensers; second, that with 80 to 90 per cent relative humidity the water

TABLE 2 SPRAY-NOZZLE CAPACITIES, GAL. PER MIN.

Pipe size of nozzle, inches	Pressures on nozzles, lb. per sq. in.					
	6	6	7	9	10	10
2	54	60	65.5	70.5	75	78
2½	77	85	92	98	103	106
3	115	125	133	140	146	151

temperature can be lowered to within 12 or 13 deg. fahr. of the dry-bulb air temperature; third, that with 20 to 30 per cent relative humidity the water temperature can be lowered about 8 deg. fahr. below the dry-bulb air temperature; and, fourth, that the loss of water is usually about 6 per cent.

To compute the temperature reduction which can be effected by a spray-nozzle installation, the following formula can be used:

$$T_2 = T_1 - \frac{(T_1 + T_x + 920)^4 - 16(T_x + 460)}{16(K \times 10^8)}$$

wherein all temperatures are in degrees fahrenheit and T_2 = temperature of cooled water after spraying, T_1 = temperature of water before spraying, $T_x = (4T_w + T_d) \div 5$, T_d = dry bulb-thermometer or air temperature, and T_w = wet-bulb-thermometer temperature, K = a constant = 5.1 for average installations operating at 6½ lb. water pressure, but it may vary from 4.4 to 5.7; it varies with the wind velocity and the pressure with which the water is forced through the spray nozzles.

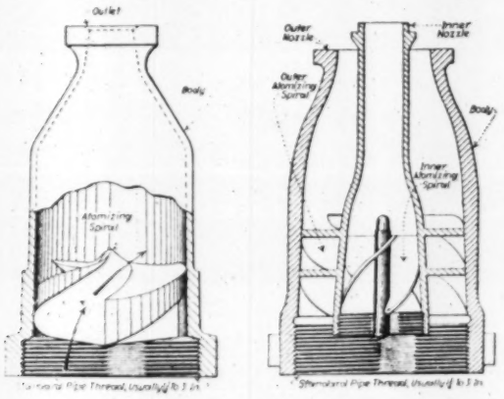
To determine the probable temperature reduction in any locality the average data for this locality have to be consulted. They may be found for a number of places in a table in *Power Plant Engineering*, Apr. 1, 1921, p. 361.

Recooling by spray nozzles may be done in one stage where a cooling of 20 to 30 deg. fahr. is sufficient, or in two stages where a greater range is desired.

The spacing of the nozzles depends mainly upon their design and size. Centrifugal nozzles of 2-in. size are usually spaced about

8 to 10 ft. from center to center, and larger nozzles may be set proportionately further apart.

A typical installation, spraying 4800 gal. per min., consists of nine rows of nozzles with eight nozzles in each row. Thus each nozzle sprays $4800 \div (9 \times 8) = 66^2/_3$ gal. per min. The rows are 20 ft. apart and the nozzles are spread 13 ft. between centers. A 2-in. nozzle (Table 2) at a little over 7 lb. per sq. in. water pressure would meet these requirements.



FIGS. 10 AND 11 TYPES OF SPRAY NOZZLES

Spray fountains should be surrounded by wind breaks in order to avoid excessive water loss during heavy winds. They may be located on power-house roofs. The power required to operate a spray fountain in connection with the steam-condenser equipment seldom exceeds 1.5 to 2 per cent of the main engine power, and the circulating pump may often be used to deliver the water directly

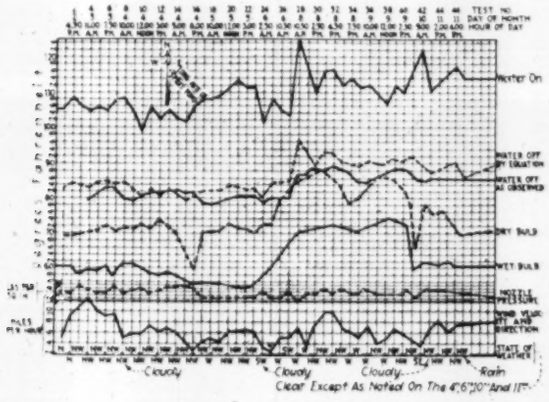


FIG. 12 DATA OF SPRAY NOZZLE TEST (CIRCULATION 5000 GAL. PER MIN.)

to the nozzles, which cannot, however, be done where barometric condensers are used. (*Power Plant Engineering*, vol. 25, no. 8, Apr. 15, 1921, pp. 408–410, 9 figs., *pd*)

RAILROAD ENGINEERING

HANDLING 9000 TONS DOWN A 1.6 PER CENT GRADE. Description of methods by which a 70-car train with automatic straight air brakes can be successfully controlled on the Norfolk & Western Railway over comparatively heavy grades.

On the Elkhorn section, one of the worst sections of the Norfolk & Western Railway, as far as grades are concerned, the handling of coal trains has been simplified by electric traction which permits the control of train movements down a 2 per cent grade by regenerative braking. For the rest of the line steam operation still obtains and the problem of train control is an important one, particularly so as the Norfolk & Western uses high-capacity cars, and, in fact, ranks as a pioneer in their introduction. At the present time, for example, the railroad is completing the construction of 500 gondola cars of 100 tons capacity, which is a considerable advance in the development of the high-capacity car. (These cars, are equipped with an entirely new type of six-wheel truck.)

As regards braking, they are equipped with automatic straight air brakes and the test train weighing approximately 9000 tons on a run from Bluefield to Roanoke is described in the present article.

This train was made up to include the Norfolk & Western all-steel dynamometer car equipped to record graphically the brake-cylinder pressure, the train-line pressure and the auxiliary reservoir pressure on the dynamometer car, and also to record the exact amount at which brake-cylinder pressure built up to and dropped below 15 lb. on the first, twenty-seventh, fifty-third and seventieth car back of the dynamometer car.

During the test run the chronograph also recorded various facts such as the drawbar pull of the locomotive, and it may be noted that on the test run the maximum pull of the single Mallet locomotive attached to the head of the train exceeded 120,000 lb. and on several occasions the locomotive developed more than 2500 hp. at speeds between 15 and 20 m.p.h.

The tests are of great interest and cannot be described in detail because of lack of space.

The most interesting of the standing emergency tests was conducted as follows: A 2-lb. reduction was made, then the valve was lapped for 20 sec., after which the brake valve was thrown in emergency position for one minute. In this test the brake cylinder on the first car developed 15 lb. pressure 19.5 sec. after the service application, while the seventieth car developed the same pressure 20.3 sec. later. The maximum brake-cylinder pressure recorded on the dynamometer car with a 20-lb. service reduction was 29.7 lb., whereas with subsequent emergency action a pressure of 56.5 lb. was developed in the brake cylinder. Upon completion of this test the first car released in 9.5 sec. after the brake valve was placed in full release, and the seventieth car released in 122 sec. after the first car released.

The action of the graduated release, which is one of the important characteristics of the operation of the automatic straight air brake, has been carefully tested and successfully demonstrated, and it proved to be possible to handle the train down the steepest grades under perfect control.

On the whole, within eight hours the train effected a gross ton-mileage output somewhat in excess of 900,000 without a hitch, which may be taken as an interesting indication of the state of development of the modern locomotive as well as of the braking equipment. (*Railway Review*, vol. 68, no. 14, Apr. 2, 1921, pp. 515–521, 9 figs., *dcA*)

REFRIGERATION

COLUMBIAN FLASK STEAM CONDENSER. Description of a condenser said to be extensively used in ice-manufacturing p'ants. The steam enters at the bottom of the head of the condenser into the first or reboiling compartment formed by baffle plates. It travels then through the entire length of the condenser, ascending into the next compartment, back through the full length of the condenser, again ascending into the next compartment, until it reaches the top compartment at the end of which is provided a small opening for the escape of foul or gassy steam, the two in the center being the main condensing compartments.

The distillate travels back over the baffle plates, descending to the bottom of the condenser in the same manner in which the steam traveled as it ascended over the baffle plates. This distillate reboils on its way back to the bottom of the condenser and is finally carried off through the distilled-water outlet in the bottom of the condenser down into the ice cans below, where it is finally frozen into ice cakes.

The steam entering at the bottom of the condenser is generally from 218 to 220 deg. fahr. with a pressure from 1/2 to 1 lb. The cooling water, which is evenly distributed over the outside of the condenser, is usually from 90 to 100 deg. fahr. The hot steam passing back and forth up through the condenser meets the distilled water and reboils it so thoroughly that by the time the distillate reaches the bottom of the condenser in the reboiling chamber, there is no further need of a separate reboiling, yet the temperature in this lower compartment is at about 212 deg. fahr.

Columbian flask condensers are made mostly by hand. The rivets are finished from the inside in order to leave a smooth surface

on the outside as a protection against the quick collection of alkalis and minerals that are found in the water. They are usually equipped with a 4-in. steam inlet and 2-in. distilled-water outlet, and an additional small outlet in the end of the condenser near the top for the escape of foul steam. (*Refrigeration*, 28, no. 2, Mar. 1921, p. 39, 1 fig., *d*)

SHIPBUILDING

An Entirely Electrically Welded Vessel. Last December at the works of the Electric Welding Company of Gothenburg, Sweden, the first electrically welded ship built in that country (the second on the European continent) was launched. The boat has a flat bottom which extends at both ends right up to the water line. The total length of the vessel is 52 ft. 6 in., breadth 13 ft. 1½ in., molded depth 7 ft., and draft 3 ft. 6 in.

The propelling machinery consists of semi-Diesel oil engines intended to drive specially constructed generators for electric welding and air compressors. The boat is to be employed along the seashore for carrying repairs to ships.

Rivets are practically absent and the sides as well as the bottom are smooth and glossy as if cast in one piece. The boat was built under special survey of Lloyd's Register, Bureau Veritas and the Swedish Government Inspection. The engine-room skylight is the only part of the whole ship that is made removable, bolts having been used.

The first entirely welded ship on the Continent was built in 1919 at Caen, France, and is now stationed in the harbor of Le Havre. It was built by a French autogenous welding company and is to be used for the same purposes as the Swedish ship. (*Marine Engineering*, vol. 26, no. 4, Apr. 1921, p. 277, 1 fig., *d*)

SPECIAL PROCESSES (See Engineering Materials)

STEAM ENGINEERING (See also Engineering Materials)

Development of the Stirling Boiler. The original Stirling boiler consisted of a single upper or steam drum and a mud drum, water tubes being expanded into the steam drum and forming drop tubes closed at the lower ends. When the boiler was placed in service, trouble developed through the burning of tubes at the bottom ends.

The first modification was to increase the number of drums by installing two steam drums instead of one. Then a third steam drum and structural-steel supports were added and other improvements made. Some seven or eight years later the water columns were connected to the center drum, in which location a true water level was indicated.

During the last 15 years there have been numerous changes made in the Stirling boiler, either in the effort to meet special and unusual operating conditions, or as a result of improvement in detail of design and construction. The principal improvements in design have been:

1 All steel drums are now placed on the same level, the same being taken from the rear steam drum, this being done largely in an effort to overcome priming troubles arising under certain conditions of feedwater.

2 Protection at the rear steam drum is given by a baffle carried on the front tube of the rear bank which is expanded into the center drum.

3 An arrangement of tubes circumferentially on the mud drum has been provided such as to give a larger superheater chamber, which is important when higher superheats are desirable and which also gives a better access of the superheater headers and handhole caps. The sizes and types ("classes") have also been standardized in a manner to reduce the number manufactured.

A section through one of the new classes is shown in Fig. 13. (*Power*, vol. 53, no. 16, Apr. 19, 1921, pp. 632–634, 7 figs. *dp*)

THERMODYNAMICS

Thermodynamic Cycles of Internal-Combustion Engines

Thermodynamic Cycles in Relation to the Design and Future Development of Internal-Combustion Engines Prof. Wm. J. Walker. A discussion of the various thermodynamic cycles and factors affecting the design of internal-combustion engines. The author claims that the outstanding feature in the thermodynamics of the internal-combustion engine distinguishing it sharply from that associated with steam practice is the necessary inclusion of the variable specific-heat factor in all fundamental analyses.

He classifies various engine types on the basis of the following three factors:

1 *The method of ignition* employed to initiate combustion. This more or less determines the *combustion efficiency* of the engine.

2 *The method of operation* employed to carry out the thermodynamic cycle of the engine. This more or less determines *the mechanical and volumetric efficiencies* of the engine

3 *The thermodynamic cycle* to which the working fluid is subjected. This more or less determines *the thermal efficiency* of the engine.

Of these three the third is the one discussed in particular detail. Figs. 14 to 16 illustrate the classes into which thermodynamic cycles

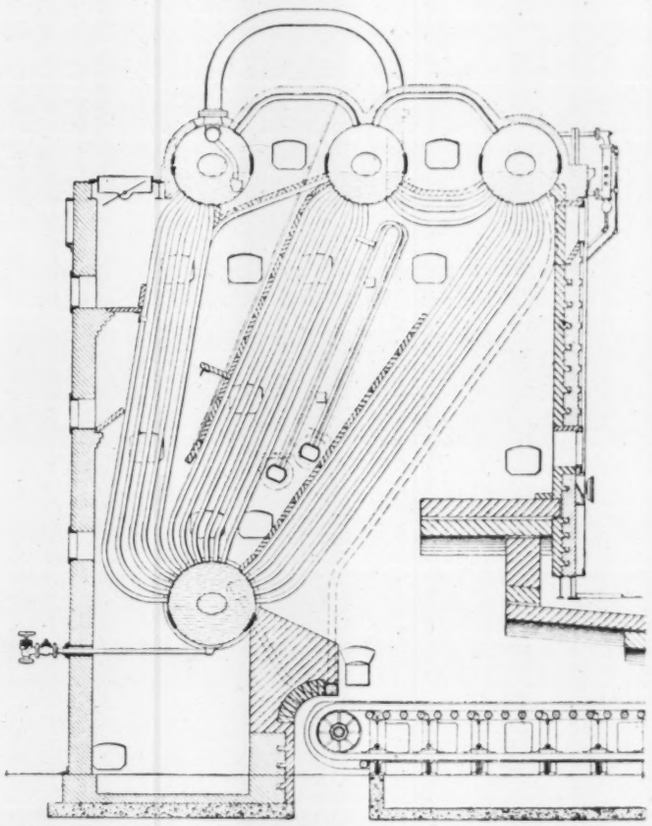


Fig. 13 Section through One of the New Classes of the Stirling Boiler.

may be divided. In Fig. 14 the full-line diagram to the left represents the constant-volume combustion cycle (C.V. Cycle) with compression-volume expansion. This is the standard cycle for most modern engines. With the dotted portion of the diagram included in the full-line left-hand portion, the figure represents the C.V. Cycle with extended expansion. So far as the author is aware, there are no engines in existence operating on this cycle at full load. The entire diagram represents the C.V. Cycle with complete expansion. This is the cycle of the well-known Atkinson engine and also of the Humphrey pump.

Similarly Fig. 15 represents the constant-pressure combustion cycle (C.P. Cycle) with the same three divisions according to expansion. The first division represents the Diesel-engine cycle, the second has no counterpart in past or existing practice, while the third is typified by the Brayton gas-engine cycle.

Fig. 16 represents the class of cycle on which engines, such as the Blackstone oil engine, are operated, and is here called the dual combustion cycle (D.C. Cycle), the heat being imparted some at con-

stant volume and the remainder at constant pressure. This cycle is also divisible as before into three sections according to degree of epansion.

As regards the combustion processes the author defines them in terms of the ratio of the pressure at the end to the pressure at the beginning of constant-volume combustion (α), and the ratio of the volume at the end to the volume at the beginning of constant pressure combustion (ρ). In this connection the author claims that it is incorrect to presume that the efficiency of the constant-pressure

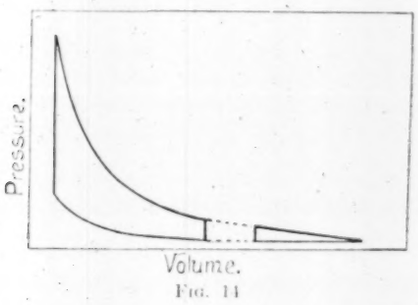


FIG. 14

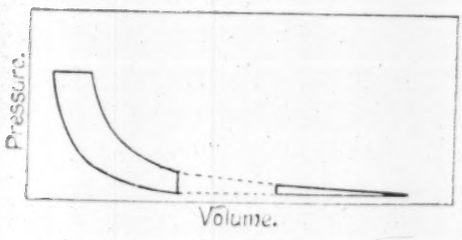


FIG. 15

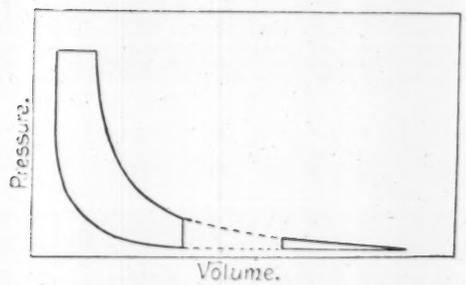


FIG. 16

FIG. 14–16 DIAGRAMS ILLUSTRATING CLASSES INTO WHICH THERMODYNAMIC CYCLES OF INTERNAL-COMBUSTION ENGINES MAY BE DIVIDED

combustion cycle is theoretically adversely affected by the addition of heat at constant volume, as for instance when a small quantity of oil burned at constant volume is used to facilitate the combustion of heavy tar oils. The discussion of this subject is very interesting, but cannot be abstracted here owing to lack of space.

Referring again to Fig. 16, the author believes such a method of additional fuel injection constitutes really an extension of the fuel combustion cycle and sees in this cycle the possible way of ultimately adopting the Diesel cycle to automobile and aero engines.

As regards the subject of variable specific heat, the author states that the question as to how much of the variability of specific heat is apparent and how much is real does not greatly matter for present purposes, and for all practical purposes it is sufficient to formulate the closely approximate law that the "apparent" specific heat varies directly with temperature. He further comes to the conclusion based on various recent experiments on air-cooled and water-cooled engines that the brake thermal efficiency actually realized approaches, according to perfection in design, to a theoretical minimum which is identical for all types of engines operating on the same thermodynamic cycle and is independent of engine speed.

The conductivity of the cylinder walls affects brake thermal efficiency, the author admits, but he believes that this diminution in brake thermal efficiency is due wholly to a diminished volumetric efficiency.

The relations between the mean effective pressures, the maximum pressures and the efficiencies of the various cycles are discussed in considerable detail and illustrated by curves. This part is not suitable for abstracting.

As regards the subject of regeneration, a belief is expressed that the raising of steam by means of the waste heat of an engine and utilizing this steam in a high-efficiency steam engine or turbine is the best and most practicable method of increasing overall efficiencies.

Some recent work carried out at the Manchester College of Technology by a research student, R. Koivulehto, in conjunction with the author, on the effect of water injection on the heat distribution in a gas-engine cylinder, has resulted in the determination of actual quantitative values relating to the amount of heat diverted from the jackets to the exhaust per pound of water injected per brake horsepower.

In connection with this, the following regenerative scheme is suggested, experimental figures being adduced in evidence of its value: The proposal is that by running a multi-cylinder engine on a maximum-efficiency dual combustion cycle of compression ratio 8 or 9 : 1, an indicated thermal efficiency of over 40 per cent is possible. By water injection a large proportion of the jacket heat would be diverted to exhaust, resulting, say, in an exhaust discharge of comparatively low temperature and containing 40 per cent of the original heat contained in the fuel. Assuming 20 per cent of this waste heat to be utilized in a high-efficiency turbine of the Rateau type, the total overall efficiency would be raised to the neighborhood of 50 per cent, and this without the introduction of any complicated steam-raising plant. The water injection also would serve to keep down the flame temperatures of the D.C. cycle.

The following figures are typical of the results obtained in the above-mentioned water-injection experiments:

Lb. of water injected per b.hp-hr	0	1.3
Exhaust-gas temperature, deg. fahr.	722	646
Percentage of exhaust heat	27	14
Percentage of jacket heat	34	20
B.hp., per cent	33	30

The paper is followed by a highly interesting discussion which unfortunately cannot be abstracted owing to limited space. (*The Journal of the Institution of Mechanical Engineers*, no. 10, 1920, Feb. 1921, original paper pp. 1235–1258, 12 figs., and discussion pp. 1258–1311, illustrated, *eA*)

VARIA

ADOPTION OF COMPULSORY USE OF THE METRIC SYSTEM OF WEIGHTS AND MEASURES IN JAPAN, Ch.-Ed. Guillaume. A telegram has been received from Shirio Kikkawa, Director of the Bureau of Weights and Measures, in Tokyo, to the effect that the Japanese parliament has passed a law making the use of the metric system of weights and measures compulsory.

In this connection it is recalled that the use of the metric system in Japan has been legal since Jan. 1, 1893, at which time the national Japanese units, shaku and kwan, were respectively fixed as 10 33 of a meter and 15 4 of a kilogram.

In China the use of metric units has been permitted since 1908 and in 1913 a bill was introduced in parliament to make its uses compulsory but has not yet been passed. The same situation exists in Siam. (*Comptes Rendus des Séances de l'Académie des Sciences*, vol. 172, no. 13, Mar. 29, 1921, pp. 795–796, *g*)

WELDING (See Shipbuilding)

CLASSIFICATION OF ARTICLES

Articles appearing in the Survey are classified as *c* comparative; *d* descriptive; *e* experimental; *g* general; *h* historical; *m* mathematical; *p* practical; *s* statistical; *t* theoretical. Articles of especial merit are rated *A* by the reviewer. Opinions expressed are those of the reviewer, not of the Society. The Editor will be pleased to receive inquiries for further information in connection with articles reported in the Survey.

ENGINEERING RESEARCH

A Department Conducted by the Research Committee of the A.S.M.E.

Research at Michigan

Prof. A. E. White, Director of the Department of Engineering Research at the University of Michigan, has recently presented a paper before the Detroit Section of the S.A.E. on Research—The Bond between the University and Industry. This has been issued as a bulletin by the University.

Professor White explains the plan of work at the University in engineering research. The control of the Department is in the hands of two committees, one known as an Administrative Committee, consisting of the Dean of the Colleges of Engineering and Architecture, the Director of the Department of Engineering Research and the heads of the various departments in Engineering and Architecture; and the second as the Advisory Board and consisting of one hundred men selected from various industrial centers of the state. The Executive Committee of seventeen members of the Advisory Board transacts the largest portion of the work of the Board.

Research Resume of the Month

A—Research Results

The purpose of this section of Engineering Research is to give the origin of research information which has been completed, to give a résumé of research results with formulas or curves where such may be readily given, and to report results of non-extensive researches which in the opinion of the investigators do not warrant a paper.

Aircraft A1-21. Air Propellers. Prof. W. F. Durand and E. P. Lesley completed in January 1921 an investigation covering the technical characteristics of performance of 12 model propellers in "yaw," that is, with the wind stream oblique to the direction of the shaft and especially when such angles of obliquity are large as in the case of helicopter flight with the propeller serving for both sustentation and traction. Each model was tested at obliquities of 90, 85, 80, 70 and 60 deg. and at wind velocities of 30, 45 and 60 ft. per sec. and for 7 to 10 rotative speeds relative to each wind speed. The data were reduced to coefficients C_1 and C_2 defined by the equations—

$$gT = C_1 \Delta N^2 D^4$$
$$gQ = C_2 \Delta N^2 D^5$$

and these are plotted on an axis of V/ND, where T = thrust, Q = torque, Δ = density of air, N = r. p. s., D = diameter, C_1 = thrust coefficient, and C_2 = torque coefficient.

Address Prof. W. F. Durand, Leland Stanford Junior University, Stanford University, Cal.

Aircraft A2-21. Air Propellers. Prof. W. F. Durand and E. P. Lesley completed in December 1920 an investigation covering the technical characteristics of ten forms of model propellers at a series of air speeds relative to r.p.m. and included in the determination of the thrust and torque coefficients and efficiency. The thrust coefficient C_1 is defined by the equation $gT = C_1 \Delta V^2 D^2$. The torque coefficient C_2 is defined by the equation $gQ = C_2 \Delta V^2 D^3$, where T = thrust, Q = torque, Δ = density of medium, V = speed, and D = diameter.

Address Prof. W. F. Durand, Leland Stanford Junior University, Stanford University, California.

Apparatus and Instruments A5-21. Calorimeter. (see *Heat A8-21*)

Automotive Vehicles and Equipment A3-21. Combustion Products. Report No. 2225 of the Bureau of Mines on gasoline losses due to incomplete combustion in motor vehicles, by A. C. Fieldner, A. A. Straub and G. W. Jones, is an abstract of a paper read before the S. A. E. in January 1921. The investigation was made for the purpose of caring for the ventilation of the vehicular tunnel under the Hudson River. The report shows the results of tests extending over ten months and compares the results of these tests with previous tests, giving diagrams and charts. Curves giving various important data are also included. The tests on 101 passenger cars and trucks of various capacities give the following results:

1 Automobile exhaust gas consists of carbon dioxide, carbonm onoxide, hydrogen, hydrocarbons, oxygen, nitrogen and water vapor, the relative proportions of which vary greatly depending on carburetor adjustment, degree of atomization, compression and other elements.

2 The important constituent of exhaust gas regarding tunnel ventilation is carbon monoxide. Physiological tests show that the maximum allowable concentration for an exposure of one hour is four parts in 10,000.

3 The carbon monoxide varied from 0.5 to 14.0 per cent in passenger cars and speed trucks on level grades at from 15 to 20 miles per hour, averaging 7 per cent. With $1\frac{1}{2}$ to 5-ton trucks at 10 miles per hour the average was 7.3 per cent. The average percentage of carbon monoxide corresponds to an air-gasoline ratio of 11.8 This is slightly richer than that required for maximum power. Maximum power mixture is 12.5; maximum-thermal-efficiency mixture, 16.0; complete-combustion mixture, 15.4.

4 The larger percentages of carbon monoxide are produced when the throttle is nearly closed or when the car is standing with the engine idling. The largest quantity of carbon monoxide is produced when the gas consumption is greatest, as when car is accelerated or running up grades.

5 Completeness of combustion varies directly as the percentage of carbon dioxide in the exhaust gas and inversely as the percentage of carbon monoxide. For constant carburetor adjustment combustion is more complete when the motor is operating under full load at normal speed. The primary factor in completeness of combustion appears to be carburetor adjustment. The efficiency of combustion varies from 50 to 95 per cent, the average being 70 per cent.

6 The combustible gas in the average automobile exhaust contains 30 per cent of the total heat of the original gasoline. This means a loss of $400,000,000 per year on the consumption of gas in 1919 with gas at 33 cents per gallon.

7 The majority of motor cars and trucks operate on a rich mixture suitable for maximum power but wasteful for gas economy.

8 The average motor-car carburetor is set for winter operation and not changed in summer. This is shown by the highest percentage of carbon monoxide and richer mixtures found in summer tests.

9 The public should realize the saving resulting from the use of lean mixtures. Taxicab and trucking companies could well afford to employ chemists to make regular control tests.

Address Director, Bureau of Mines, Washington, D. C.

Boilers A1-21. Evaporators. A study of measures to reduce the effects of priming in evaporators was the subject of a thesis completed by D. K. Dungan and H. Stewart. Address Prof. W. F. Durand, Leland Stanford Junior University, Stanford University, Cal.

Cement and Other Building Materials A8-21. Tolerance of Coarse Aggregate Under $\frac{1}{4}$ In. The Experiment Station of Purdue University has made experiments on the properties of Indiana sands and gravels sieved to different gradings of size. During the last two years the results show that 20 to 30 per cent of the coarse sand which passes over with the pebbles may be allowed to remain in the coarse aggregate without detriment. The report is published by the American Concrete Institute February, 1921. Address Dean A. A. Potter, Engineering Experiment Station, Lafayette, Ind.

Fuels, Gas, Tar and Coke A8-21. Continuous Calorimeter. See *Heat A8-21.*

Fuels, Gas, Tar and Coke A9-21. Third Semi-Annual Motor Gasoline Survey. Report No. 2220 of the Bureau of Mines gives the third semi-annual motor-gasoline survey made in January 1921. One hundred and fifteen samples were collected and analyzed from nine cities. The difference between the averages for the nine cities in this survey and the seven cities included in the 1920 survey is very slight. The analysis of the distillation curves shows that the curve is slightly below the Federal Specifications until the 85 per cent point is reached, when it rises slightly above. Tae average results from the nine cities are as follows:

Specific gravity	0.744
Baumé degrees	58.3
First drop	113 deg. fahr.
20 per cent	197 deg. fahr.
50 per cent	261 deg. fahr.
90 per cent	377 deg. fahr.
End point	431 deg. fahr.
Average boiling point	264 deg. fahr.
Percentage recovered	95.9

Address Bureau of Mines, Washington, D. C. F. G. Cottrell, Director.

Glass and Ceramics A2-21. Ceramic Industry. Report No. 2212 by D'Orsay A. Lyon to the Bureau of Mines outlines the investigation made by the Ceramic Station of the Bureau at Columbus, Ohio. The work of finding bond clays for graphite crucibles and the investigation of foreign and domestic graphites is almost complete. The Station is working on dolomite refractories for furnace linings. The work of the Station is to produce brick which will not disintegrate in storage or when placed in furnace. It is also working on white pottery clays and Ohio fire clays. Address Director, Bureau of Mines, Washington, D. C.

Glass and Ceramics A3-21. Dissolved Gases in Glass. Dissolved gases in glass is the subject of Bulletin No. 118 of the Engineering Experi-

ment Station of the University of Illinois. The investigation was made by Prof. Edward W. Washburn, Frank F. Footitt, and Elmer N. Bunting. The investigation shows that—

1 All varieties of glass in the finished state contain dissolved gases.

2 The amount of this dissolved gas is sufficient to cause the glass to effervesce violently if the pressure upon it be suddenly reduced while it is in a fluid condition.

3 The amount and composition of the dissolved gas vary greatly with the type of glass and the details of the melting and fining procedures.

4 In the three types of industrial glass examined the volume of the dissolved gases (measured under standard conditions) varied from 0.2 to 2 times the volume of the glass itself.

5 Carbon dioxide, oxygen, and nitrogen were found in varying amounts in the gas.

In addition, as a result of this experimental work a convenient apparatus for measuring and analyzing the dissolved gases was developed, and an improved type of vacuum furnace for the manufacture of gas-free glass was constructed.

The paper gives a number of figures showing the apparatus used and the method of procedure. Price 20 cents. Address Director, Engineering Experiment Station, University of Illinois, Urbana, Ill.

Heat A8-21. RECORDING CALORIMETER. Technical Paper No. 2 of the Fuel Research Board under the Department of Scientific and Industrial Research of Great Britain has been issued. It is a Report on the Simmance Total-Heat Recording Calorimeter by Thomas Gray and Alfred Blackie. It contains a record of the operation of this instrument on town gas during five months with occasional adjustments. During the second period the instrument was supplied with coal gas and water gas in order to check the accuracy of the gravity governor when subject to rapid and extreme changes of density and calorific values. Tables of results and curves illustrating the experiments are also included. Obtained at 10½d. from H. M. Stationery Office, Imperial House, Kingsway, London, W. C. 2.

Heat A9-21. THERMOMETERS. The Bureau of Standards requires that partial-immersion thermometers be used for work in which the thermometer is not completely immersed. Few people are willing to make stem corrections for full-immersion thermometers when partially immersed. The advantages of total and partial immersion thermometers are given in the *Journal of Industrial and Engineering Chemistry* for March 1921. Address S. W. Stratton, Director, Bureau of Standards, Washington, D. C.

Internal-Combustion Motors A1-21. COMBUSTION PRODUCTS. See *Automotive Vehicles and Equipment A4-21.*

Machine Design A1-21. SHRINK FITS. The Bureau of Standards has investigated the feasibility of making shrink fits on so-called body-bound bolts by contracting the bolts by using liquid air or by expanding the bolt by the use of an explosive within a small hole in the center of the bolt, the bolt having a sliding fit in the hole. The results of the investigation showed that with 1/1000 in. over size for a cylindrical pin contracted by liquid air the withdrawing frictional resistance was equal to 2150 lb. per sq. in., while with an explosive charge the frictional resistance was equal to 2180 lb. per sq. in. Address, S. W. Stratton, Director, Bureau of Standards, Washington, D. C.

Machine Design A2-21. SCREW THREADS. The report of the National Screw Thread Commission has been issued as a Miscellaneous Publication No. 42 of the Bureau of Standards and is obtainable from the Superintendent of Documents at 15 cents per copy. It was abstracted in MECHANICAL ENGINEERING during June and July 1920.

Petroleum, Asphalt and Wood Products A4-21. ASSAYING OIL SHALES. A convenient and reliable retort for assaying oil shales is the subject of Report No. 2229 of the Bureau of Mines by L. C. Kerrick. Address Director, Bureau of Mines, Washington, D. C.

Properties of Engineering Materials A3-21. PHYSICAL PROPERTIES. The Bureau of Standards has issued Circular No. 101 which is obtainable from the Superintendent of Documents. It presents in readily accessible form the best available data on the strength and related properties of materials. Address S. W. Stratton, Director, Bureau of Standards, Washington, D. C.

Refrigeration A2-21. PROPERTIES OF AMMONIA. The Bureau of Standards has recently completed a set of accurate measurements on the thermal properties of ammonia. The work completed is sufficient for the preparation of a table of properties, and such a table has been issued in mimeographed form. The results do not differ greatly from the tables now in general use. The properties, of superheated ammonia have not been investigated to a sufficient amount for the construction of a table. This will be done. Address S. W. Stratton, Director, Bureau of Standards, Washington, D. C.

Road Materials and Equipment A1-21. SLATE DUST IN SURFACE MIXTURES. Report No. 2230 by Oliver Bowles describes tests that prove the feasibility of using slate dust as a portion of the mixture used for the surface of asphalt roads. The tests suggest the possibility of this application and indicate that the use of slate flour as a filler would result in improved highways and would utilize the waste from slate quarries. Address Director, Bureau of Mines, Washington, D. C.

Steam Power A1-21. CALORIMETER SAMPLING TUBES. See *Apparatus and Instruments A4-21*, MECHANICAL ENGINEERING, May, 1921.

Ventilation A2-21. DUST IN AIR. Report No. 2214 by S. H. Katz to the Bureau of Mines is on the subject of the dust in the air of granite-working plants. To determine the dustiness three methods were used, two of which involved catching the dust particles from a volume of air at high velocity on a sticky-coated glass plate. They were then counted under a microscope. Other samples of dust were obtained by filtering 15 cu. ft. of air through a layer of granulated sugar held in a glass tube. The sugar retains the dust. After this the sugar is dissolved in pure water and a small portion of the water is examined microscopically. The entire sugar solution is then filtered through a pure paper, and after burning off the paper the dust is weighed on a delicate balance. The dustiness of the air is finally expressed in millions of particles per cu. ft. and on a weight basis in milligrams per cu. ft. Address Director, Bureau of Mines, Washington, D. C.

B—RESEARCH IN PROGRESS

The purpose of this section of Engineering Research is to bring together those who are working on the same problem for coöperation or conference, to prevent unnecessary duplication of work, and to inform the profession of the investigators who are engaged upon research problems. The addresses of these investigators are given for the purpose of correspondence.

Air B3-21. AIR FLOW. The nature of the static pressure changes near the outlet of tubes to check results which show a region of static pressure below the atmosphere, extending back into the tubes and depending on the average velocity of the air; and the static pressure drop along various-shaped tubes, particularly those having an oblong cross-section with circular edges, for various velocities of air, are the subjects of investigation in the Research Department of the Westinghouse Electric and Manufacturing Company, Pittsburgh, Pa. Address C. E. Skinner, Manager.

Electricity, General B1-21. CONTACT RESISTANCE. Contact resistance of various metals under different pressures. Address Prof. Paul Cloke, University of Arizona, Tucson, Ariz.

Fuels, Gas, Tar and Coke B1-21. AUTOMOBILE FUELS. A study by Prof. C. A. Norman, Engineering Experiment Station, Ohio State University, Columbus, Ohio.

Heat B14-21. HEAT TRANSMISSION. The effect of air-cell asbestos as a pipe covering for hot-air pipes. Research Department, Westinghouse Electric & Manufacturing Company, Pittsburgh, Pa. Address C. E. Skinner, Manager.

Hydraulics B3-21. STEAM FLOW IN ELBOWS. A study of the frictional drop due to the flow of steam through elbows. Address A. M. Greene, Jr., Rensselaer Polytechnic Institute, Troy, N. Y.

Metallurgy and Metallography B7-21. DETECTION OF COPPER SULPHIDE ORES BY THE USE OF AUDIO FREQUENCY CURRENT AND WAVES. Address Professor Paul Cloke, University of Arizona, Tucson, Ariz.

Steam Power B1-21. FLOW OF STEAM IN ELBOWS. A study of the frictional drop due to the flow of steam through elbows. Address, A. M. Greene, Jr., Rensselaer Polytechnic Institute, Troy, N. Y.

Transmission B1-21. ROPES AND TACKLE. The Engineering Experiment Station of the State College of Washington is preparing a short bulletin on the Care and Use of Ropes and Tackles. Address Dean H. V. Carpenter, State College of Washington, Pullman, Wash.

Water, Sewage and Sanitation B1-21. PIPE THAWING. A bulletin on electrical pipe-thawing outfits is being prepared by the Engineering Experiment Station of the State College of Washington. Address Dean H. V. Carpenter, Pullman, Wash.

C—RESEARCH PROBLEMS

The purpose of this section of Engineering Research is to bring together persons who desire coöperation in research work or to bring together those who have problems and no equipment with those who are equipped to carry on research. It is hoped that those desiring coöperation or aid will state problems for publication in this section.

Chemistry, Inorganic C1-21. FUSED CAUSTIC SODA. The action of fused caustic soda on commercial alloys such as cast iron is a problem for which the Mathieson Alkali Works, Inc., at Niagara Falls desires coöperation. Address R. E. Gegenheimer, Chief Chemist.

Metallurgy and Metallography C3-21. FUSED CAUSTIC SODA. See *Chemistry, Inorganic, C1-21.*

D—RESEARCH EQUIPMENT

The purpose of this section of Engineering Research is to give in concise form notes regarding the equipment of laboratories for mutual information and for the purpose of informing the profession of the equipment in various laboratories so that persons desiring special investigations may know where such work may be done.

University of Wisconsin D1-21. The Engineering School of the University of Wisconsin has special equipment for testing pipe coverings and complete equipment for air measurement, including a Thomas electric meter with a capacity of from 50 to 200,000 cu. ft. per hour, pitot tubes and thin-plate orifices. The laboratory is equipped for comparative tests of shaft bearings. A 50-hp. Sprague electric dynamometer is arranged for the testing of automobiles. A 15-ton ammonia compressor is available for research work on cold-pipe insulation. The laboratory is equipped with the following apparatus:

A 28-hp. Foos engine for producer gas, city gas, kerosene and gasoline.

A 50-hp. cross-compound poppet-valve, Nordberg engine.

A 25-hp. semi-Diesel oil engine with various small steam engines and internal-combustion engines, including those for automobiles.

Address Prof. A. E. Berggren, Asst. Professor of Steam and Gas Engineering, University of Wisconsin, Madison, Wis.

E—Research Personnel

The purpose of this section of Engineering Research is to give notes of a personal nature regarding the personnel of various laboratories, methods of procedure for commercial work or notes regarding the conduct of various laboratories.

American Leather Research Laboratory E1-21. The American Leather Research Laboratory, 180 South St., New York, has been discontinued and the work has been transferred to the College of Engineering and Commerce of the University of Cincinnati. The Tanners' Council of the United States is supporting research work of a fundamental nature and in the environment of a university where men are available who have specialized in colloids and physiological chemistry as well as bacteriology this work can be carried on advantageously. Address Prof. George D. McLaughlin, University of Cincinnati, Cincinnati, Ohio.

Kansas State Agricultural College, E1-21. The Engineering Experiment Station is planning to print three bulletins: namely,

1 Service Tests of Paints and Painting Materials
2 Water Heaters in the Home
3 Work of the Road Materials Laboratory.

The Experiment Station is at work on the following subjects:

1 Heat Transmission of Insulating Materials
2 Endurance Tests of Lubricating Oils
3 Automatic Tests of Ventilators
4 Atmospherical Resistance to Movement of Motor Vehicles
5 Tests of Belt Lacings
6 Temperature Stresses in Rigid Pavement Slabs
7 Wear Tests of Concrete
8 Road-Building Materials of Kansas
9 Concrete in Highway Construction.

In most of these investigations the work is well under way and many data have been obtained.

Address Dean R. A. Seaton, Kansas State Agricultural College, Manhattan, Kan.

North Carolina State College E1-21. The new Laboratory of Mechanical Engineering is about completed and equipment is now being installed. The work is under the supervision of Prof. Wm. J. Dana, West Raleigh, N. C.

Pennsylvania State College E1-21. Engineering Experiment Station. The Experiment Station of Penn. State College has issued thirty bulletins up until May 1920. Of these four deal with cement, concrete and building construction, three with electric substances, five with heating and ventilation, and five with internal-combustion engines and coals. Address Director, Engineering Experiment Station, Penn. State College, Pa.

University of Utah E1-21. Engineering Experiment Station. The Engineering Experiment Station of the University of Utah has published thirteen bulletins up to December 1920 as follows:

1 Test of Utah Brick (out of print)
2 Tests of Macadam Rock
3 The Construction and Maintenance of Earth Roads
4 The Economical Design of Reinforced-Concrete Beams
5 Measurement of Flowing Streams. A Simple, Accurate Method of Using the Weir
6 Leaching a Lime-Zinc Ore with Acids
7 Results of Experiments on Sewer Pipe and Drain Tile
8 Patents Relating to Oil Flotation Processes
9 Report of the Department of Metallurgical Research, State School of Mines, University of Utah, 1914, 1915, 1916
10 Mine Sampling and the Commercial Value of Ores
11 Descriptive Bulletin of the Department of Metallurgical Research, University of Utah
12 The Mineral Industry of Utah
13 Extraction of Potash from Low-Grade Alunite.

Address Director, Engineering Experiment Station, University of Utah, Salt Lake City, Utah.

University of Washington E1-21. Engineering Experiment Station. The Experiment Station at the University of Washington, Pullman, Wash., has issued the following bulletins:

How to Measure Water
Sewage Disposal for the Country Home
Water Supply for the Country Home
Construction and Maintenance of Earth Roads
Fuel Economy in Domestic Heating and Cooking
Cost of Pumping for Irrigation.

Address Dean H. V. Carpenter, Pullman, Wash.

F—Bibliographies

The purpose of this section of Engineering Research is to inform the profession of bibliographies which have been prepared. In general this work is done at the expense of the Society. Extensive bibliographies require the approval of the Research Committee. All bibliographies are loaned for a period of one month only. Additional copies are available, however, for periods of two weeks to members of the A.S.M.E. or to others recommended by members of the A.S.M.E. These bibliographies are on file at the office of the Society.

Steam Power F2-21. Steam Flow. Measurement of Steam Flow in Pipes. A bibliography of 10 pages. Search 3297. Address Arthur M. Greene, Jr., Rensselaer Polytechnic Institute, Troy, N. Y.

Petroleum, Asphalt and Wood Products F3-21. Fuels. History and Properties of Petroleum Fuels. A bibliography of 8 pages. Address Arthur M. Greene, Jr., Rensselaer Polytechnic Institute, Troy, N. Y.

CORRESPONDENCE

Contributions to the Correspondence Department of Mechanical Engineering are solicited. Contributions particularly welcomed are discussions of papers published in this Journal, brief articles of current interest to mechanical engineers, or suggestions from members of The American Society of Mechanical Engineers as to a better conduct of A.S.M.E. affairs.

The Engineer Cabinet Member

To the Editor:

It appears that engineering training should be an excellent thing in preparation for public life. An engineer is trained rigorously to avoid error, for a machine that is wrong cannot be made right by bluff, appeals to patriotism, censorship, or propaganda. He usually extends his training to his relations with his fellow-men, and I submit that the average engineer has less trouble with his subordinates than does any other class of men.

But I question Mr. Miller's comment in the April Mechanical Engineering that "Whether or not Mr. Hoover is to be followed by a long line of engineers in high and responsible positions, depends far more upon him and how he shall conduct himself during his term of office than upon anything or anybody else."

The more we examine it the more it appears that Mr. Hoover is an unusual engineer. He is more than a mining engineer or industrial engineer; he is a humanity engineer. He knows not only Americans but Englishmen, Frenchmen, Germans and others. Yet has engineering an old profession, been compelled to wait all these years for Mr. Hoover to blaze the way?

If it is true that we have something that the world needs and has failed to get, the fault is ours. We have not been good salesmen.

Recently an engineer presented an important report to a city council. His report showed careful preparation and he is a man of unquestioned ability. But his attitude was that "Facts, being established, leave no room for opinions, traditions or fallacies." *He* knew they were facts but the council did not. He took little pains to sell the facts to the council.

The human body is a machine, the ultimate achievement of the Great Engineer. It has a pump, with suction and discharge valves, that will run a hundred years without a stop.

The human mind is a wonderful thing, but during the thousands of years of evolution it has been ingrained with mere opinions, fallacies and instincts of various kinds which are harmful today; and due to the facilities afforded by science and particularly by the branch engineering—it does widespread damage when it runs amuck.

All engineers must take hold. No one man can do it all. We must demonstrate that as a group we can be trusted to show a way out of the present state of world affairs.

JOEL R. BELKNAP.

Lansing, Mich.

Concerning Non-Scientific Management

TO THE EDITOR:

May I call your attention to the heading of an editorial article in the April number of the Journal? This heading is "A Place for Non-Scientific Management." Personally, it seems to me that the use of such a heading as this in a scientific journal is somewhat bad taste, to say the least. The general impression one would obtain by reading this article is at variance with modern development, and its use in a journal of the standing of MECHANICAL ENGINEERING does not seem warranted. Doubtless certain of the plant methods suggested are worth while, but if they do fit a particular plant to the best possible advantage, they are scientific and not "non-scientific."

SANFORD E. THOMPSON.

Boston, Mass.

Production Minus Consumption Equals Capital Not Value

TO THE EDITOR:

In the Secretary's letter in Section 2 of the March issue of MECHANICAL ENGINEERING, reference was made to the formula $p - c = r$. I have been accustomed to read and believe that production minus consumption equals capital, not value, and that it is by increment of capital that society is advanced.

The political economy of John Stuart Mill is summed up in the formula: Production minus Consumption gives Capital, and selective limitation of population so that pro rata capital increases is the way of human progress. This seems a prerequisite and a more fundamental law than the "binding time" idea of Mr. Polakov, Mr. Korzybski and Mr. Wolf.

I am anxious to determine whether the practical "conservation of capital" idea as set forth in my paper on Appraisal and Valuation Methods[1] is not the fundamental law we seek to know, and consciously develop and strengthen for social advantage.

"Dogmas," "police forces" and "the man-made law of barristers" are human inventions to hold the gain and to consolidate the advance of the race in conserving capital, and as instrumentalities of progress they should not be disparaged or weakened, unless we wish to risk losing the gain, sliding back and beginning again.

Consider two current topics: (1) A dose of capital in the form of farm tractors, etc., seems to have changed the bandit Villa from something less human into a factor in industrial production; (2) Current reports quote the Bolsheviki leaders as saying that (foreign) capital is the solution of the Russian chaos—they will produce if capitalized.

If Bolsheviki means, as I am informed, those who haven't anything, J. S. Mill's principle of industrial philosophy seems more fundamental than anything enunciated by Mr. Polakov or Mr. Korzybski, for the Bolsheviki are successful at "binding time" but not at conserving capital.

With a full appreciation of the brutalities and hardships of the capitalistic system, I would emphasize "conservation of capital" as the practical instrumentality for industrial and human advancement. Conservation mus always take precedence over service in anything that is to continue. This emphasizes, as the essence of the maligned capitalistic system, the idea of abstinence.

Production minus Consumption gives the Abstinence Factor (conservation of service or capital ratio), and where this is high in a nation, society or individual, power increases, and with it, happiness, which is the sensation of increase of power in any form or in any field.

Any "service" or "time binding" which is not geared to conservation of capital does not advance humanity—it may even weaken and destroy it. It is not sound industrial philosophy.

Los Angeles, Cal. DAVID H. RAY.

[1] MECHANICAL ENGINEERING, December 1919, page 93.

The Theory of Crowned Pulleys

[A letter received not long ago in the office of MECHANICAL ENGINEERING raised the question as to the theory on which a crown-faced pulley is used instead of a straight-faced pulley with flanges, and why flanged pulleys are not more generally used. The matter was referred to various members of the Machine Shop Practice Division of the Society and the theory agreed upon by them has been submitted in a letter from F. O. Hoagland, chairman of that Division. A letter was also received from George A. Perry, Springfield, Vt., in which the same explanation was offered. Mr. Hoagland's letter follows.—EDITOR.]

TO THE EDITOR:

The pulley with the crowned face is used because of the well-known tendency of flat belts to climb to the largest diameter of a tapering pulley. The theory for this is illustrated in Fig. 1, in which A is a pulley of exaggerated taper, running in the direction of the arrow. The point at which the belt first comes in contact with the pulley is indicated at D. If the belt is to pass around the pulley without climbing, that is, in the direction of lines G and H, then the side E would have to stretch, as the circumference of the pulley at G is greater than at H.

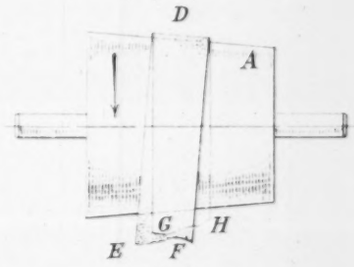


FIG. 1

The stiffness of the belt and its resistance to stretching or bending sideways compel it to follow the direction of lines E and F. If, then, we use a pulley tapering so that the largest diameter is in the center of the path of the belt, it will resist any tendency to deviate in either direction.

As Henry J. Eberhardt expresses it, the highest part of the crown practically acts as a barrier to keep the belt from running off.

It is true, of course, that considerable attention must be given to the amount of crown necessary, according to the various widths of belts and the conditions under which they operate.

Flanged pulleys are frequently used, yet to insure good action on the belt, generous allowances must be made so that the belt will not rub against the flange, and at the same time the flanges should be deep to prevent the belt from riding should it come in contact with the pulley. A low-flanged pulley is absolutely dangerous.

Furthermore, members of the Machine Shop Practice Division all concede that flanged pulleys are much more expensive to manufacture and should be used only where it is impossible to apply crowned pulleys. From experience covering a period of 45 to 50 years, it is recommended that crowned pulleys be used wherever possible.

F. O. HOAGLAND.

Worcester, Mass.

The Properties of Steam

TO THE EDITOR:

The review of Professor Callendar's Properties of Steam abstracted in the April issue of MECHANICAL ENGINEERING from London *Engineering*, contains two surprising statements, which, if true, place our American steam tables in an unfavorable light. On page 259 occurs the assertion that "the elaborate tables compiled in America on the basis of German experiments and formulas are claimed to fail to satisfy the test which consists in that the work done in a given cycle should be the same whether it be measured on the temperature-entropy chart or on the indicator diagram." Again on page 260, the test—

$$c_p = \frac{dH}{dT}\Big]_p = \frac{T}{J}\frac{dV}{dT}\Big]_p \frac{d_p}{d_T}\Big]_\phi$$

is mentioned and the statement is made that all tables based on the German formulas fail to meet this test, the discrepancy being as much as 20 per cent, and that the only tables that do satisfy the test are those based on Callendar's work.

We may assume that the statements in question originated with the author of the review in *Engineering;* for it is inconceivable that Professor Callendar could have shown such ignorance of the recent researches on the properties of steam.

As pointed out in the preface to the Properties of Steam and Ammonia, a steam table should have two qualities, accuracy and thermodynamic consistency. While our older tables may be regarded as fairly accurate, they lack consistency. To such tables the preceding criticisms are quite applicable. If, however, a table is calculated from a thermodynamically consistent formulation, the tests mentioned are automatically satisfied. There are at least two formulations, based on the German experimental data and not all on Callendar's work, that are thoroughly consistent.

It is easily shown that the Goodenough formulation satisfies this test which is asserted to be the exclusive property of Professor Callendar's equations. Using Callendar's notation, the fundamental equation[1] from which the general expression for entropy is derived is—

$$ds = c_p \frac{dT}{T} - \frac{1}{J}\left(\frac{dv}{dT}\right)_p dp$$

To obtain the derivative $(dp/dT)_\phi$, take ϕ = constant and $d\phi = 0$

Then the equation becomes—

$$c_p \frac{dT}{T} = \frac{1}{J}\left(\frac{dv}{dT}\right)_p dp, \quad (\phi = \text{constant})$$

or—

$$c_p = \frac{T}{J}\left(\frac{dv}{dT}\right)_p \left(\frac{dp}{dT}\right)_\phi$$

which is the required expression for c_p in terms of p, v, and T.

The other criticism relates to the quality of areas on the temperature-entropy and pressure-volume planes. The point was forcibly brought out in a criticism of an American steam table in London *Engineering*, June 9, 1916. The heat turned into work in the ideal Rankine cycle is the difference $H_1 - H_2$ between the total heats at the beginning and end of the adiabatic expansion. The work of the cycle is, however, given by the integral $\int_1^2 vdp$ consequently the first law requires the equality—

$$J\,(H_1 - H_2) = -\int_1^2 vdp$$

If a table is not consistent, the two members of the last equation, as calculated from the tabular values, may show a considerable discrepancy. A table that has this defect may be justly criticized. In the case of any consistent table the two members of the equation are necessarily identical. To show the identity for the Goodenough formulation, take again the adiabatic relation (with $d\phi = 0$)—

$$c_p \frac{dT}{T} = \frac{1}{J}\left(\frac{dv}{dT}\right)_p dp$$

or—

$$c_p dT = \frac{T}{J}\left(\frac{dv}{dT}\right)_p dp$$

The total heat H being a function of T and p, we have—

$$dH = \left(\frac{dH}{dT}\right)_p dT + \left(\frac{dH}{dp}\right)_T dp$$

$$= c_p dT + \left(\frac{dH}{dp}\right)_T dp$$

$$= \left[\frac{T}{J}\left(\frac{dv}{dT}\right)_p + \left(\frac{dH}{dp}\right)_T\right] dp$$

The equations[2] for v and H are—

$$v - c = \frac{BT}{p} - (1 + 3ap^{1/2})\frac{m}{T^n}$$

$$H = \alpha + \beta T + \frac{\gamma}{T^2} - \frac{mn(n+1)}{JT^n} p(1 + 2ap^{1/2}) + \frac{cp}{J} + H_0$$

Hence—

$$\left(\frac{dv}{dT}\right)_p = \frac{B}{p} + (1 + 3ap^{1/2}) \frac{mn}{T^{n+1}}$$

$$\frac{T}{J}\left(\frac{dv}{dT}\right)_p = \frac{BT}{Jp} + (1 + 3ap^{1/2})\frac{mn}{JT^n}$$

$$\left(\frac{dH}{dp}\right)_T = -(1 + 3ap^{1/2})\frac{m(n+1)}{JT^n} + \frac{c}{J}$$

$$\frac{T}{J}\left(\frac{dv}{dT}\right)_p + \left(\frac{dH}{dp}\right)_T = \frac{1}{J}\left[\frac{BT}{p} - (1+3ap^{1/2})\frac{m}{T^n} + c\right] = \frac{v}{J}$$

Substituting v/J for the bracket in the preceding equation, the result is—

$$dH = \frac{1}{J} vdp$$

and integrating with J constant,

$$J\,(H^2 - H^1) = -\int_1^2 vdp$$

By a similar procedure it may be shown that Professor Heck's consistent formulation also satisfies these tests.

From the reviewer's statement one naturally receives the impression that the satisfaction of these tests is dependent on the experimental data used. That is, tables based on the German experiments do not meet the requirements, tables based on Callendar's experiments do meet them. Such an inference is entirely erroneous. The satisfaction of these tests is solely a matter of consistency. A table may, however, be consistent and yet grossly inaccurate; such, in fact, was Smith and Warren's table based on Callendar's earlier equations.

In his latest work Professor Callendar has apparently discarded completely the Munich experiments. Whether in so doing he has improved the accuracy of his results is an open question.

G. A. Goodenough.

University of Illinois, Urbana, Ill.

[1] Properties of Steam and Ammonia, G. A. Goodenough, p. 18.

[2] Properties of Steam and Ammonia, pp. 8 and 10.

In the method of flying recently proposed by Prof. Raimund Nimfuhr of Vienna, it is intended to imitate the process of flying of an insect, that is, to set up powerful reacting vibrations in the air by a series of very rapid strokes or beats. The underneath section of the wing will take the form of a flexible membrane, which will be set beating or pulsating by the action of pneumatic pumps alternately filling and emptying the air bags in the wing. These pulsations can be made also, according to the theory, to propel a machine forward through the air by the wave-like motion of the atmospheric vibrations they set up. Another essential feature is a flexible extremity at either end of the wing, which, again by pneumatic action, can be made to extend or contract in imitation of the "reefing" of a bird's wing.

Rubber is a peculiar material, contracting when heated and expanding when cooled, and has been largely used for railway buffer and draw springs. An important property that comes into question in some classes of springs is not so much elasticity, as ordinarily understood, but proof resilience, i.e., the energy which a material can store when stretched up to the elastic limit. In that respect rubber far surpasses all other materials, a paper in the February 1921 issue of the *Journal of Industrial and Engineering Chemistry* giving the following values for proof resilience in ft-lb. per cu. in.: Gray cast iron, 0.373; soft steel, 3.07; rail steel, 14.1; tempered spring steel, 95.3; structural nickel steel, 14.7; rolled aluminum, 7.56; phosphor bronze, 4.06; hickory wood, 122.5; vulcanized rubber, 14,600. Thus the spring steel has less than a hundredth of the resilience of rubber.

WORK OF THE A.S.M.E. BOILER CODE COMMITTEE

THE Boiler Code Committee meets monthly for the purpose of considering communications relative to the Boiler Code. Any one desiring information as to the application of the Code is requested to communicate with the Secretary of the Committee, Mr. C. W. Obert, 29 West 39th St., New York, N. Y.

The procedure of the Committee in handling the cases is as follows: All inquiries must be in written form before they are accepted for consideration. Copies are sent by the Secretary of the Committee to all of the members of the Committee. The interpretation, in the form of a reply, is then prepared by the Committee and passed upon at a regular meeting of the Committee. This interpretation is later submitted to the Council of the Society for approval after which it is issued to the inquirer and simultaneously published in MECHANICAL ENGINEERING.

Below are given the interpretations of the Committee in Cases Nos. 322 (reopened), 337, and 342 to 346 inclusive, as formulated at the meeting of April 19, 1921, and approved by the Council. In accordance with the Committee's practice, the names of inquirers have been omitted.

Boiler Code Interpretations

CASE NO. 322 (Reopened)

Inquiry: What material is it necessary to use under the requirements of the Boiler Code for the Y-fitting, also for the safety-valve body, for safety valves to be operated at a pressure of 225 lb.? May cast iron be used for this purpose?

Reply: It is the opinion of the Committee that the Y-fitting referred to may be made of cast iron provided the temperature does not exceed 450 deg. fahr. as stipulated in Par. 12. The safety-valve body need not be of steel unless it is to operate with superheated steam. (See Par. 289)

CASE NO. 337

Inquiry: In applying reinforcing plates within the drums of water-tube boilers to strengthen the shell where the tubes enter, as shown in Fig. 12 (of the Interpretations), what is the requirement of the Boiler Code for the thickness of the plate and the strength of the riveting to compensate for the material removed in forming the tube holes?

Reply: Reinforcing plates shall be riveted to the shell, and the tubes shall be expanded into the inner and outer plates so that the rivets and tubes will hold the plates together in accordance with the rules for stayed surfaces.

The spacing of the rivets with respect to the tubes shall conform to Par. 199 for stayed surfaces using a valve of 135 for *C*. and shall be based on a unit pressure equal to the pressure that can be carried by the inner plate with a factor of safety of 5. (NOTE: Where a reinforcing plate is inside the stem drum it is the inner plate; where it is outside and there is no inner reinforcing plate, the unreinforced shell of the drum is the inner plate.)

The tension in rivets and tubes shall conform to Pars. 220 and 232.

The combined drum shell and reinforcing plate or plates shall have a facter of safety of not less than 5 in ligaments, when calculated in accord with Pars. 192 and 193, also in rivet connections. When reinforcing plates or butt straps are exposed to flame or gas of the equivalent temperature, the joints shall be protected therefrom.

CASE NO. 342

Inquiry: Is it permissible in a heating boiler to be operated at a pressure not to exceed 15 lb. per sq. in., where cross-bracing is required in the side furnace sheet of a locomotive-type boiler between the center line of the cylindrical portion and the crown sheet, to locate a through cross-rod one-half of the staybolt pitch below the center line, as shown in Fig. 15?

Reply: It is the opinion of the Committee that the method of staying described does not conflict with the requirements of the Code when the working pressure does not exceed 15 lb. per sq. in.

CASE NO. 343

Inquiry: What constant will it be necessary to use in the formula in Par. 199 of the Boiler Code, for a surface braced with through stays having inside and outside nuts, but omitting washers?

Reply: It is the opinion of the Committee that where through stays are used with inside and outside nuts, but omitting washers, the constant of 135 should be used in the application of the formula in Par. 199.

CASE NO. 344

Inquiry: In complying with the requirements of Par. 289 for a safety valve used on superheater, is it necessary that the entire casing of the safety valve be made of steel?

Reply: It is the opinion of the Committee that the intent of Par. 289 is that the *body* of a safety valve includes all parts of the body and casing which come in contact with the boiler steam or the steam discharged, and therefore in the construction submitted the casing shall be made of cast steel for use with superheated steam.

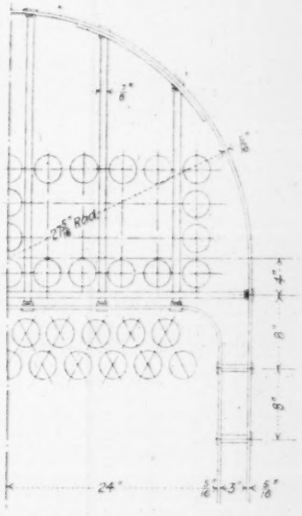


FIG. 15 DETAIL OF SIDE FURNACE SHEET OF LOCOMOTIVE-TYPE BOILER SHOWING STAYING

CASE NO. 345

Inquiry: Is it the intention of Par. 335*b* of the Boiler Code, that hot-water boilers must be built according to the rules for power boilers when either the grate area exceeds 10 sq. ft. or the maximum allowable working pressure exceeds 50 lb. per sq. in., or is it the intention that this requirement applies only when both of the above limits are exceeded?

Reply: It is the opinion of the Committee that the requirement of Par. 335*b* applies only when both of the limits therein specified, are exceeded in the hot-water boiler.

CASE NO. 346

Inquiry: Is it permissible, in the application of the requirements in the A.S.M.E. Boiler Code for safety valves for heating boilers, to take advantage of the proportional difference between bevel-seated and flat-seated valves provided for in the safety-valve rules for power boilers?

Reply: It was the intent of the Committee that Table 9 of the Boiler Code should cover the application of safety valves to all heating boilers, no matter what the character of the seat. Attention however, is called to the fact that where the conditions specified in Table 9 are exceeded, the formula in Paragraph 358 may be used.

MECHANICAL ENGINEERING

A Monthly Journal Containing a Review of Progress and Attainments in Mechanical Engineering and Related Fields, The Engineering Index (of current engineering literature), together with a Summary of the Activities, Papers and Proceedings of

The American Society of Mechanical Engineers

29 West 39th Street, New York

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Contributions of interest to the profession are solicited. Communications should be addressed to the Editor.

C 55 The Society as a body is not responsible for the statements of facts or opinions advanced in papers or discussions.

LESTER GRAY FRENCH

LESTER GRAY FRENCH, editor and manager of MECHANICAL ENGINEERING, and for thirteen years editor of the publications of the Society and latterly assistant secretary, died on April 18 at the French Hospital, New York City, from septic poisoning following an operation.

Mr. French was born in Keene, N. H., in April 1869. He received his technical education at the Massachusetts Institute of Technology, from which he was graduated in 1891 with the degree of S.B. He served the year 1891–92 with the Cranston Printing Press Company as draftsman, and then became connected with the International Correspondence Schools, Scranton, Pa., as instructor in mechanical engineering. Leaving this institution in 1895 he went to Providence, R. I., where he entered the employment of the Builders Iron Foundry as assistant to the superintendent. In 1897 he became editor in chief of *Machinery*, continuing in this position until 1906, when he resigned to take up the publication of technical books, among them being one of the earliest American treatises on the steam turbine, of which he was the author. In 1908 he was made editor of the publications of the Society, serving faithfully and ably to the last in that capacity.

Particulars regarding his activities at Scranton and on *Machinery* are given in the tributes printed below from his associates, Professor Goodenough and Messrs. O'Neill, Rogers and Flanders.

Mr. French was elected a junior of the Society in 1899 and became a member in 1912. He was also a member of the Engineers' Club of New York City, and of the University Club of White Plains, N. Y., where he resided.

Resolutions of appreciation of the work of Mr. French were adopted by the Council of the Society and by the Boiler Code Committee at their April meetings, as follows:

Resolved: That the Council of the American Society of Mechanical Engineers hereby expresses its deep regret and sorrow at the loss by death of Mr. Lester Gray French, esteemed Member of the Society since 1899 and for the past fourteen years Editor of its Journal and other publications, acting also as Assistant Secretary.

With rare ability, good judgment and devotion, Mr. French has contributed in an important way to the growth and development of the Society. Not only our own Members, but the Engineering Profession, owe to him a debt of gratitude.

The Boiler Code Committee learns with great regret that Lester G. French, the assistant secretary and editor of the Society's publications, has passed away after protracted illness.

The publications have been brought to a high standard under his direction, enhancing the work and prestige of the Society. Too much credit cannot be given Mr. French for this major activity of the Society, notwithstanding that it is understood that all work of the Society is directed by Committees. Mr. French, by a rare combination of enterprise, vision, tact and devotion has been personally responsible for much of the Society's progress. Mr. French has been a strong supporter of all standardization movements, particularly the Boiler Code movement, and his loyal coöperation in the work of the Committee has been thoroughly appreciated. Be it therefore

Resolved: That the Boiler Code Committee acknowledge and record their appreciation of the life work of Lester G. French, and be it further

Resolved: That a copy of these resolutions be sent to the family and also the Secretary of our Society.

The following letters of appreciation of the professional work of Mr. French and of his sterling personal qualities have been received from members and other friends well fitted by long acquaintance to bring them into review:

LETTERS OF APPRECIATION

When it was perceived by some of us that the Society ought to develop its Journal into something like its present state and the problem of a suitable man to conduct its editorial work arose, I happened to discuss with Mr. French some features of our problem, not thinking he would be available, for I knew that he had plans for the future that I supposed would be more attractive to him. To my surprise, he was interested, and to my gratification he declared that to give up his plans and undertake the work would be very agreeable to him.

Neither of us, as I remember, mentioned the subject of compensation—his interest in the matter was entirely from the standpoint of the service which he saw the prospect of rendering to the profession in helping to develop such a journal of engineering as we had in mind and which he agreed ought to be published and could be best published by a great engineering society.

Though the Society had not at the time achieved greatness, measured by our present standards, he saw that it could achieve it, and his greatest wish and ambition were to help in that work.

Bringing to the service the experience and knowledge based upon successful and high-class technical editorial work, he, with rare ability, tactfulness and complete absorption and devotion, has built for himself a monument that will endure so long as there are engineers having an appreciative understanding of what such work as he did really means.

By nature, retiring and unobtrusive—conservative, yet not afraid of new ideas, nor of departures from the beaten path when they seemed justified, he was peculiarly fitted for the task he undertook to perform; his one failing being that he could not be prevented from driving himself beyond his strength.

He had the faculty of attaching to himself and holding other capable and devoted workers and has left behind him an organization that can continue the work and develop it to the fullest degree; but a very large share of whatever success "The Journal" may hereafter attain will be due to the splendid foundation he did so much to construct.

As his personal friend, acquainted with him since the time when he was a student at "Tech," and as an officer of the Society, in close touch with his work, I find my pen inadequate to fully express my admiration and regard for him, and I feel sure that so long as the Society can attach to itself such men as Mr. French it will continue to grow in power and influence.

FRED J. MILLER.

The life work of Mr. French was such that every one is anxious to give him credit for the wonderful foundation he laid for the publications of the Society, especially MECHANICAL ENGINEERING.

His special qualifications as an editor included the highest ideals, vision and executive ability, and his permanent contribution to the Society was the realization of an ambition for the Society's publications in coöperation with the Publication Committee, and the building of an organization to carry on the work.

Mr. French's inspiration thus lives on to guide the work of the Society, and all will take great satisfaction in trying to make the publications of the Society attain Mr. French's ambition. CALVIN W. RICE.

It has been my pleasure to have known Mr. Lester Gray French for many years. His clear perception of engineering problems, his art as a writer, and his ability as an editor placed him in the front rank of engineering editors. While it was the professional side that brought us together, it is the fine personal qualities that stand out conspicuously now as I think of the many pleasurable occasions when we were brought together, either by painstaking suggestions for a revision of some of my contributions or in the general conferences connected with our society conventions. It was always a genuine pleasure and inspiration to meet him.

JAMES HARTNESS.

French gave what was best in him to our Society, which he served long and well. He was straightforward and upright and always ready to lend a helping hand. He will be remembered by all of his associates as a true and sincere friend. D. S. JACOBUS.

The services rendered by Mr. Lester G. French to The American Society of Mechanical Engineers have been greatly appreciated by those who have been close enough to know of his work. His first thought was always for the good of the Society. He was most diligent, intelligent, and conscientious. The results of his efforts to maintain the publications of the Society in volume and quality will be of lasting benefit. CHARLES T. MAIN.

As an ideal companion, a staunch friend, a true engineer and a remarkable editor, Lester Gray French will remain long in the hearts and memories of his friends and associates in his future-building work for the Society.

GEORGE A. ORROK.

In the passing of Lester G. French The American Society of Mechanical Engineers has lost one of the most faithful and efficient servants and many of us have lost a good friend and a pleasant companion. To those who have been in close contact with the work of the Society at its headquarters it is not necessary to dwell upon the importance of the work performed by Mr. French, but to those whose geographical situations make this contact difficult it may not be amiss to remind them of the extent to which a society of this kind is indebted to faithful workers, such as Mr. French, for the growth and prestige of the organization. Presidents, vice-presidents, and managers come and go, they establish policies and change methods of procedure. But no organization of this kind can grow and prosper that cannot command the services of such men as Mr. French, who by faithful and painstaking labor bring the policies of the management into full effectiveness.

It was my great pleasure during the several years I have served upon the Meetings and Program Committee to work very closely with Mr. French and I came to like and admire him greatly. His patience, enthusiasm and good judgment in the difficult task of procuring and selecting good papers for the Society did much to make service upon this Committee a real pleasure, and all who have had the experience of serving in any way in connection with the publications of the Society will join me in recording my profound regret that his usefulness and sunny influence have been brought to an untimely end. It is not too much to say that the present high standards of the publications of the Society and the success that has attended these publications financially are due in no small measure to his energy and good judgment.

The Society has lost a faithful servant, the world has lost a fine high-minded citizen, and many of us mourn the loss of a good friend, whose place will be difficult to fill.

DEXTER S. KIMBALL.

LESTER GRAY FRENCH

During the summer of 1893 Mr. French was one of a group of four young college graduates occupying a room in the Coal Exchange Building, Scranton, Pa. These men were engaged in writing the original instruction papers for the Correspondence School of Mechanics, as it was then termed. Mr. French wrote several of the papers, his special contribution being the Applied Mechanics. Toward the close of the year he was transferred to another office and put in charge of the clerical force that examined student's work.

The papers written by Mr. French were certainly among the best that have been published by the International Correspondence Schools. They showed on the part of the author excellent grasp of the subject-matter, fine judgment in the selection and arrangement of topics, and power of clear exposition. This early experience in a rather unique field of technical writing was undoubtedly a good preparation for Mr. French's subsequent work as an editor.

The high character of Mr. French's work gained him the respect of his associates; his excellent social qualities gained their warm and lasting friendship. In his relations with his associates Mr. French was uniformly courteous and considerate; he was ever ready with suggestions or offers of assistance. Outside of the office he was the ideal companion for an excursion to the hills or a social evening.

The short summer passed too quickly. The group was broken up never to be reunited. But in the minds of each the memory of the association with Mr. French will ever remain.

G. A. GOODENOUGH.

Lester G. French was editor of *Machinery* from 1897 to 1906, a nine-year period during which the machine-tool industry of this country was laying the solid foundations for the rapid development that was to follow. By education, extended study and practical shop experience, Mr. French was well equipped for the editorship of a technical journal in the metal-working field and rendered valuable service in that capacity. He had a natural talent for explaining mechanical principles and describing shop practice, especially for the practical man at work in the industries, who wants his information and data direct and hasn't the time, even if he has the taste, for fine writing. Mr. French knew his subjects and wrote with clearness and accuracy—valuable attributes in a writer whose work is essentially educational. A man of sound character, an associate it was a pleasure to work with.

M. J. O'NEILL.

My acquaintance and association with Lester Gray French began in 1899 on joining the editorial staff of *Machinery*. At that time the trade and technical journals presented a variety of industrial and engineering topics before their readers; hardly one specialized as do so many now. We were then passing through an era of change in the industrial world when the importance of the machine shop was just beginning to be recognized and the upbuilding of our present great machine-tool industry was in the early stages. Although personally more interested in power engineering, Mr. French recognized the desirability of specializing on machine-shop practice, machine-tool design and development, and initiated a policy that has been successfully followed by those who came after him in the management of *Machinery*.

Mr. French was a man who endeared himself to his associates. Modest, unassuming and possessed of unusual ability, he rarely asserted his opinions in contradiction of others, but by the force of example and ability won the respect of those with whom he worked. It was with sincere regret that our business association was dissolved when I took on the burden of editorial management of *Machinery* in 1906.

The development of the A.S.M.E. Journal under his expert management was in large measure due to editorial foresight and wisdom. The Journal, in my opinion, stands preeminent among engineering publications. Variety of engineering interests today makes it difficult to edit a publication that will carry universal appeal to engineers of so many affiliations as represented in the A.S.M.E. membership, but Lester Gray French succeeded to a most notable degree. It is with profound sorrow that I write this brief tribute to his personal qualities and editorial ability.

FRED E. ROGERS.

Lester French was a friend to me for seventeen years. First as my chief on the editorial staff of *Machinery*, later as a roommate in a house in the west 80's, and finally in the close coöperation of the work of the Society our lines have been in contact throughout that period.

His was a big heart and a high courage in a small body. Untiring energy and absolute honesty of workmanship were his also. He lived and spent himself for the Society. Its position in the professional world today is due in no small measure to his faithful and intelligent administration of the charge laid upon him.

It would be impossible to express in words what was the real beauty of his character; but those who knew him intimately will love best to remember the health and purity of his sentiments. It is not that he was sentimental; but for children, for home, for family, for friends, for country scenes, for all relations and situations that reach to the roots of our common human nature, he kept an open channel to his heart. To have really known him is to have enriched one's life to its end.

RALPH E. FLANDERS.

Lester French and I were classmates in college, taking the same course and becoming members of the same college fraternity. Later we were near neighbors and for some time lived together. This close personal relationship gave an opportunity for knowing the true man hidden away under his New England reserve and extreme modesty.

Capable and efficient, a quick and a hard worker in spite of ill health for years, he accomplished much in his profession. At the same time he was always interested in those things that make for the general good of the community. A man of high ideals, fond of music, art and literature, gifted with a keen sense of humor, always optimistic, he was the most interesting of companions and the truest and most loyal of friends. A more thoughtful and unselfish man in his home relations could not be found. It was his delight to anticipate every desire of those dear to him and to make the home circle one of constant happiness.

Proud we are of his life and his courageous end; happy, too, in the memory of all the joy he has brought into our lives and of the example he has given us of a life well lived.

CHARLES W. AIKEN.

No activity of The American Society of Mechanical Engineers so directly reaches the great body of its membership as does its publishing business. Few of the Society's membership know to what a large extent the efficient

conduct of its publications has been due to the faithful and efficient service which Mr. French, as the Society's editor, has so long rendered. Under his leadership the Society's monthly journal has been transformed from a barren reprint of papers read at the meetings to a great, influential technical journal.

Mr. French's task has been no easy one. The editor of a publication carried on by a society has to serve many masters, and the masters change year by year. Under these circumstances, to maintain a continuity of policy and of development—and these are necessary to success—calls for rare patience, tact and wisdom.

We all owe a debt to this quiet, modest man whose use of his talents in the service of his profession has been a large factor in its upbuilding; and whose fine personality won for him a wide circle of friends.

CHARLES WHITING BAKER.

I knew Mr. French from the time he first entered the editorial service of *Machinery*. It was my privilege to have been in close contact with him in editorial work upon which I was engaged. The most impressive fact about Mr. French to me was his invariable honesty—honesty to himself, to his ideals, and honesty in his work. This loss is a personal one to me which I feel keenly. The loss to the mechanical engineering profession is greater than anyone knows, even those who were closest to him.

The publication MECHANICAL ENGINEERING is L. G. French's monument, a living monument and a wonderful one. I regard the success of this publication as being due to him more than to any other individual.

I hope the members of the Society will think of him with pride whenever they see this journal. G. M. BASFORD.

The life of Lester G. French was a refutation of the theory that an engineer does not concern himself with the human element. Accessible, cordial, never too busy to give his attention to any demand for coöperation or help, his personality was an important factor in the spirit of hospitality of the Engineers' Building. Forgetting himself, he went through the many months of ill health with the spirit of Stevenson. His contributions to engineering through his many years of devotion to the Journal of The American Society of Mechanical Engineers, where the best of engineering theory and practice is recorded, insure a high place for him in the history of engineering achievement, but his warm-hearted interest in humanity and its advancement mean more than this and mark his achievement as a giver of happiness minutes to the world. FRANK B. GILBRETH.

My own experience with Mr. French leaves a very happy impression in my mind. He always seemed to have the interest of the Society at heart and to be high-minded about it. I went into his office many times and always came away with a feeling of having been helped. It will be very difficult to replace him. IRA N. HOLLIS.

The Society has lost a splendid servant, the engineering profession one of its outstanding spokesmen and all of us a loyal friend. We have experienced a very real loss. MORRIS L. COOKE.

The Society has lost a very useful and efficient member who had its interests a theart at all times and with whom it was a great pleasure for his associates to work. FREDERICK A. SCHEFFLER.

All this he was—and more—to those whose privilege it was to be in daily association with him in his work, and who, having shared in his clean enthusiasms and experienced the unfailing kindliness and consideration it was ever his nature to bestow, will hold him in affectionate and enduring memory.

Memorial to Frederick Winslow Taylor

The Taylor Society, formerly the Society to Promote the Science of Management, has recently issued a volume as a memorial to Frederick Winslow Taylor. This volume contains addresses delivered at the funeral of Mr. Taylor on March 24, 1915; at a memorial meeting held under the auspices of the society at the University of Pennsylvania, October 22, 1915; and at Mr. Taylor's home, Philadelphia, October 23, 1915.

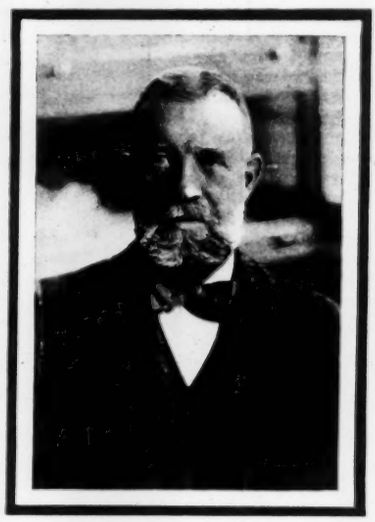
The speakers at the funeral of Mr. Taylor were James M. Dodge and Morris L. Cooke. Those who spoke at the memorial meeting on October 22 were Harlow S. Person, president of the society, Rudolph Blankenburg, mayor of Philadelphia, Carl G. Barth, Henry L. Gantt, Sanford E. Thompson, Louis D. Brandeis, and James M. Dodge. Papers by Charles de Freminville, Paris, Prof. A. Wallichs, of the Royal Polytechnic School of Aix-la-Chapelle, Germany, Henri Le Chatelier, Institute of France, and J. J. Sederholm, University of Helsingfors, Finland, abstracts of which were read at the memorial meeting, are printed in full in this volume.

Copies of the volume have been deposited in the principal public libraries and libraries of engineering societies of the United States and of foreign countries, where they may serve as an inspiration to the thousands who have accepted and are putting into practice his teachings.

GEORGE J. FORAN

George Jesse Foran, manager of the condenser department of the Worthington Pump and Machinery Corporation and the associated companies of the International Steam Pump Company, died Thursday afternoon, May 12, at his home in New York City, after an illness of some weeks.

Mr. Foran was born in Bosten, Mass., Jan. 22, 1862. He was graduated from the Massachusetts Institute of Technology in 1883 and in the fall of that year entered the works of The Deane Steam Pump Company, with which firm he remained until 1886. He then became associated with the George F. Blake Manufacturing Company, where he served as salesman in the engineering field for several years, later acting also as consulting engineer, with special reference to engineering design and construction of water works, condensing and air-compressor installations, and tests and investigations in New England. Upon the completion of the new Blake Works in East Cambridge he became office manager and head of the estimating and cost department, originating the cost



GEORGE J. FORAN

system then installed. Later he returned to the engineering sales department.

In 1901, after the International Steam Pump Company was formed, Mr. Foran went to New York to accept the position which he filled up to the time of his death. During the war he served upon the committees on condensing apparatus of the U. S. Shipping Board and War Industries Board and as chairman of the American Engineering Service of the Engineering Council, which handled all questions of personnel between the various departments of the U. S. Government and the four national engineering societies.

Mr. Foran was a leader in the development of high-vacuum apparatus from the very beginning, and was responsible for the design of a large number of important installations of this type in the United States. He also accomplished a large amount of original investigation work in the several fields of mechanical engineering.

Mr. Foran was not only a collector of works of art and a connoisseur of considerable attainment, but was also especially well posted on tennis and a valued contributor to various publications, all of which is illustrative of the versatility of the man.

Mr. Foran became a member of The American Society of Mechanical Engineers in 1887 and was active in its committee work, especially as chairman of the Condenser and Heater Sections of the Power Test Code Committee and as a member of the Publication Committee. By virtue of his special knowledge of numismatics he was appointed on the new committee of the Council on Design for the A.S.M.E. Medal. He was also a member of the Verein Deutscher Ingenieure, the American Association for the Advancement of Science, the Engineers' Clubs of New York and Boston, and the Mohawk Golf Club, Schenectady; and an associate member of the American Society of Naval Engineers.

Mr. Foran's wise counsel will be missed at the Society's head-

quarters, where he was a frequent visitor. His interest in the work of the Society was uniformly great, and he was always ready and willing to render assistance to the Secretary's office upon any matter of inquiry. He was particularly close to the committee activities and to the work of the New York Section, and these especially will feel the loss of his friendly interest.

Faithfulness of Committees

The Society has been very proud of the devotion of ist Boiler Code and other Committees, who over a long period of years have turned out such valuable work at much personal sacrifice, but we doubt if there is any record of attendance on a protracted conference quite equal to the following:

The Joint Committee of the American Society of Civil Engineers, the American Society for Testing Materials, the American Railway Engineering Association, the American Concrete Institute and the Portland Cement Association, on Standard Specifications for Concrete and Reinforced Concrete, recently met in the rooms of the Society on a Wednesday at nine o'clock, and continued almost uninterruptedly until midnight. On Thursday they met again at nine o'clock, and with similar persistency remained in session until half-past three on the morning of Friday. They again assembled at nine-thirty on Friday, and continued until ten o'clock Friday night, convening for the fourth day on Saturday morning.

It is not to much to say that such sacrifice for the benefit of the industries and the engineering profession cannot fail to advance not only the progress of the arts and industries, specifically, but the general prosperity of our whole nation.

CALVIN W. RICE.

Governor James Hartness Awarded John Scott Medal

In recognition of his development of the flat turret lathe, used in making artillery, James Hartness, governor of Vermont, was awarded the John Scott Medal at a meeting of the American Philosophical Society held on April 23 at Philadelphia.

In 1888 Mr. Hartness became associated with the Jones and Lamson Machine Company of Springfield, Vt., which specialized on turret lathes and was then manufacturing a practically standard lathe in the form of a high turret machine with various features of power feed, lever-operated back gears, etc. Mr. Hartness immediately began the development of the flat turret lathe, embodying the principles now universally used in all turret lathes for doing bar work. The principle feature of the improvements was the provision of adjustable blades and back rests in the same holder, to which the severe strains of cutting were thus confined without permitting deflection and lack of truth, even in turning the most slender variety of work.

The John Scott medal is provided for by the income of a fund bequeathed in 1816 to the City of Philadelphia by John Scott, a chemist of Edinburgh, Scotland. Up to the present year a sum of $20 has been presented with the medal, but the fund has accumulated to so large an amount that by a decree of Court the Board of Directors of City Trusts was authorized to increase the premiums to an amount not exceeding $800. The award to Governor Hartness is one of the first to be made according to the revised provisions.

THE HYDRAUCONE REGAINER, ITS DEVELOPMENT AND APPLICATIONS IN HYDROELECTRIC PLANTS

(*Continued from page 380*)

seen that the use of the hydraucone regainer on low-head plants is almost a necessity if reasonably good efficiencies are to be obtained. These comparative efficiencies are based on the wheels operating at their best speed and best efficiency, that is, when the discharge from the runner is nearly axial. At any other speed or gate opening the discharge of the water wheel is accompanied by more or less whirling, that is, the absolute velocity of the water leaving the runner is much greater at full load than given in Table 1. Furthermore the whirling action of the water in the discharge is much more effectively used in the hydraucone regainer than it is in the curved draft tube, because of the radially extending passages within which this whirling action produces outward pressure by centrifugal force.

The field of application of the hydraucone regainer will be greater on low-head plants, although it is now being installed in connection with two 40,000-hp. units which are to operate under a head of 421 ft. Hydraucone regainers are in operation or in course of construction in twenty-five hydroelectric power plants, being used with horizontal-shaft as well as vertical-shaft wheels. These hydraucone regainers are to operate under heads varying from 8 ft. to 421 ft. and with water wheels developing from 150 to 40,000 hp.

The most notable installation of the hydraucone is that in Station No. 3 Extension of the Niagara Falls Power Company at Niagara Falls, New York. Unit No. 16 is equipped with a hydraucone regainer of the flat-plate type, as shown in Fig. 17. At the time of the purchase of the water wheel for this unit it was still argued by some that curved draft tubes of proper design would

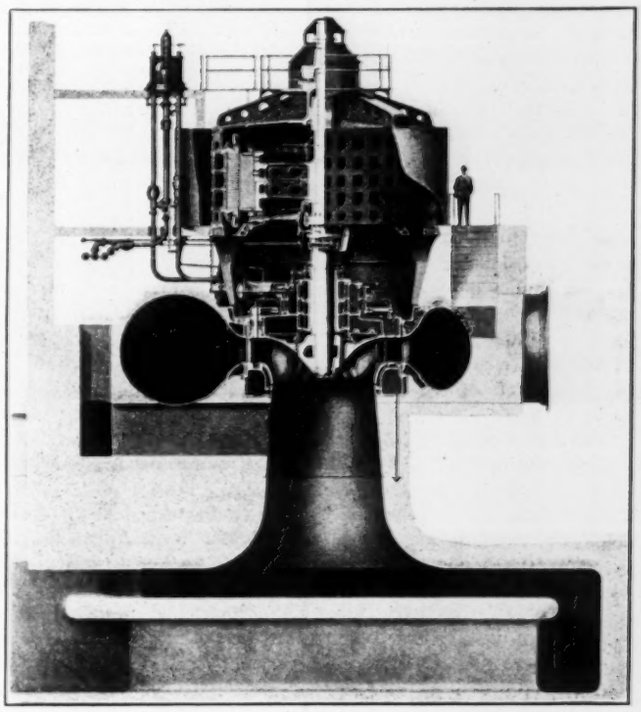


FIG. 17 HYDRAUCONE REGAINER OF FLAT-PLATE TYPE INSTALLED IN STATION NO. 3 EXTENSION OF THE NIAGARA FALLS POWER COMPANY

give as high an efficiency as that claimed for the hydraucone regainer. The engineers of the Power Company accordingly conducted a long series of experiments with various devices, which finally resulted in the development of a conoidal chamber with a cone center similar to that shown in Fig. 1 for units Nos. 16 and 17. The best model with cone center had the proper-shaped conoidal chamber for regain, and when the cone center was removed from the model, it was found that the efficiency was no lower than with the cone in place. The use of the new substitutes for curved draft tubes at this plant resulted in a water-wheel efficiency of 93 per cent being obtained, which is corroborative evidence of the value of the hydraucone principle for the regaining of pressure from velocity

Every one familiar with hydroelectric power-house operation where curved draft tubes are employed has frequently noticed the boiling and disturbance of the water at the outlet from the curved tubes. This disturbance is clearly an evidence of inefficiency and loss of energy which should be more effectively utilized. The hydraucone regainer provides a means for efficiently regaining the energy discharged from the runner for useful effect upon the water wheel within the limited space available in the power-house foundations.

The Essentials of an Engineering Education

Joint Meeting of New York Section of A.I.E.E. and Metropolitan Section of A.S.M.E. Discusses Training of Practical and Theoretical Engineers

THE problem of engineering education has received much attention during these years of reconstruction following the war. That phase of the problem dealing in particular with the theoretical engineer was considered at the evening session devoted to the subject of engineering education by the New York Section of the American Institute of Electrical Engineers and the Metropolitan Section of The American Society of Mechanical Engineers on April 22, 1921.

Dr. Comfort A. Adams acted as chairman and in opening the meeting emphasized the fact that there are two ways of carrying on an engineering educational institution. One is to offer courses which will supply the students with the superficial knowledge of the practical side of the subject, and the other is to provide the scientific foundation upon which engineering is built; to teach him to scrutinize the data upon which he bases the analysis for the solution of any problem, and then to build on that foundation a structure of his own. Unless engineering education is scientific, in its foundation and in its method, it is not education at all.

Walter Rautenstrauch, professor of mechanical engineering at Columbia University, was introduced as the first speaker. He stated the topic of the evening as The Theoretical Engineer—What Is He? Is There a Place for Him? And How Shall He Be Trained? In his treatment of the subject he divided engineering into two general classes, theoretical and practical. The practical engineer he defined as one able to follow a precedent; of the operating type, able to construct something new but within rather limited range. To illustrate what he meant by the theoretical engineer, Professor Rautenstrauch outlined some developments in mechanical engineering and showed how men of genius well grounded in the science of mathematics and physics, such as Unwin, Fairbairn and Rankine, studied the failures in machine parts and developed therefrom the science of the strength of materials and machine design. He also used the work of Rankine, Clausius and Hirn in thermodynamics, and Reuleaux, Unwin, Robinson and MacCord in kinematics as examples of the scientifically trained theoretical engineer. He further explained the capacity of the theoretical engineer as one who not only is informed on scientific facts and laws but also is able to recognize their embodiment or absence in any engineering project. In the ability to do this Professor Rautenstrauch drew a fine distinction between the purely scientific or academic type of mind and the engineering type of mind. The academic type is illustrated by the student who is able to solve a complete mathematical problem when all the facts are clearly set before him. It requires an entirely different type of mind, however, to take a particular problem, to determine the scientific principles applying, to set forth the facts clearly and to arrive at a conclusion through the capacity to recognize just what the problem is. This type of mind is the engineering type of mind.

Professor Rautenstrauch was positive that there is a place for the theoretical engineer, especially as we are now entering upon an era of refinement when the rough constructive work formerly performed is no longer found satisfactory. The speaker felt that the young engineer should be encouraged to enter industries which have not been touched at all by the scientific engineer, such as cotton and rubber mills, where the engineer is generally the master mechanic. In the training of the theoretical engineer he emphasized the importance of teaching the complete theory, not a partial theory, and of imparting the theory of engineering which bases engineering not only on the sciences of mathematics, physics and chemistry, but also upon economics.

Unless a machine can be built cheaply enough to meet the demands, it should never be built; and there is absolutely no use in designing a machine if its cost of production or operation exceeds what can properly be paid.

The effect of a proper amalgamation of the purely scientific and technological aspects of engineering with the economic and commercial principles upon which successful practice is founded, is to create in the student that sense of proportion and judgment which tends to economize his efforts in contributing to scientific progress and invention.

Professor Rautenstrauch also stated that there is no question in the minds of thoughtful men that the most important thing in an engineering education, or in a college education in general, is the inspirational value of the instructor. Unless the student is guided to a desire for service; unless he is inspired with his work so that he loves it and wishes to use his talents for the service of his fellowman, that student fails to be educated.

F. L. Bishop, dean of the school of engineering at the University of Pittsburgh, in his opening remarks endorsed Professor Rautenstrauch's words urging the young engineer to enter new industries. He divided engineers into two classes, the general engineer and the theoretical engineer. The general engineer is the man who has a broad general knowledge of engineering subjects, and can apply that knowledge in an effective way to present engineering problems. The theoretical engineer is a man highly trained in the fundamentals of science and mathematics who can apply research results to engineering. Dean Bishop likened the theoretical engineer to the pioneers who link up the discoveries of the explorer with the known world. He takes the new discoveries of pure science, examines them, determines their application to a given industry, and indicates the manner in which they may be effectively applied. The general engineer then carries on the manufacturing of this material according to the laws laid down.

In the training of the theoretical engineer Dean Bishop said that the theoretical engineer should have a knowledge of the industries and how scientific discoveries as such are applied which can be obtained only by actual experience in industry, and which should be obtained at as early an age as possible. A portion of this knowledge of industry can best be obtained in some form of the so-called coöperative system of engineering education, the object of which is to give the student a background upon which he can base his theoretical courses and to provide him with a very necessary inspiration. It makes the college courses real; he appreciates their value.

Criticism that the engineering schools have weakened their theoretical and laboratory courses in order to introduce more practical work is appearing with greater frequency. The faculties of engineering schools receive many recommendations from practicing engineers who believe that the curriculum should be made stronger in their particular fields.

However, teaching is in itself possibly the greatest of all professions, and the members of a faculty understand quite clearly just what the boy from high school can absorb. The practicing engineer seldom has any conception of these limitations.

Dean Bishop then proceeded to discuss the report of the Joint Committee on Engineering Education presented by Dr. Mann and the study by Professor Walters on scholarship and eminence in engineering, reaching the conclusion that taken together the two furnish an instance of positive correlation between intellect and character. In other words, those men who rank high in the knowledge of fundamentals also rank high in character, judgment and efficiency. Thus the scholastic standing of the engineering graduate is a measure of his character, his judgment, and his efficiency.

In closing, Dean Bishop stated that there is such a person as a theoretical engineer, and that his place is between the pure scientist and the general engineer. He can be trained, but there will not be any large number of men so trained because the pay of such men at present is entirely inadequate and the engineering schools of the country are not sufficiently well manned or equipped. There is, Dean Bishop affirmed, no first-class engineering school to be found in America.

In support of the last and rather startling statement made by Dean Bishop the chairman said that he would guarantee to take the graduates in electrical engineering from any institution in this

country and prove in a five-minute oral examination of each one, in 98 or 99 per cent of the cases, that the men do not understand in any thorough fashion the fundamentals of the subject; that in most cases they do not even know the meaning of the words they use; that they are carried through analyses of comparatively complicated problems, but in a machine-like superficial way, neglecting most of the variables, so that they get into the habit of a kind of loose thinking which so affects all their work that they cannot be counted on for any sound results.

C. R. Dooley, of the personnel and training department of the Standard Oil Company of New Jersey, told of the need in that company of the intensely trained research man and his importance to engineering development. In the training of engineers he stressed one point as most important, and that is that the process of education should be one that would help the man along the line in which his tendencies lie.

In the discussion following the presentations of the evening, H. B. Shaw, of the Henry L. Doherty Company, spoke about the work that his company does in the selection of technical graduates. Mr. Shaw quoted some of that company's specifications for technical graduates: "The graduates should be men who have been trained to think for themselves, have conservative judgment but are not bound by precedent; who can be trusted to try out new and untried methods; men who think straight and think through to conclusions; men who having will for action, act promptly, effectively and justly; men who quickly familiarize themselve swith a situation, all its vital factors, and then form sound judgments which they have the ability to express so as to convince and stimulate others." In closing he stated as his belief that engineers should be trained thoroughly in fundamentals, and should gain an understanding of the larger problems of life, even if they later specialize theoretically.

Capt. O. S. Beyer, consulting engineer, New York City, emphasized the need of the engineers' having a more complete understanding of the economic principles governing their work.

Dr. Harlow S. Person, managing director of the Taylor Society, made three points: First, engineering means something bigger than it meant when the term was first used. It embraces the discovery of new principles and laws, the application of these practically, development work, management work and large administration work. Engineering education is responsible for training men for these functions.

Second, engineering curricula do not contain enough subjects in management, administration and business in general.

Third, training must be fundamental, making the student familiar with fundamental principles common to the various fields of engineering, including management engineering and human engineering.

Mr. Farley Osgood, chairman of the New York Section of the A.I.E.E., emphasized the need of training the student to think for himself. The problem of an engineering education, he stated, resolves itself into straight thinking.

Prof. W. I. Slichter bespoke a broad training for the engineer in the cultural subjects, such as history, economics, etc. He desired to see engineers taking a larger part in the entire activities of the human race.

News of the Federated American Engineering Societies

Participation in Government Reorganization

THE American Engineering Council has recently made several important decisions in regard to its relation to the reorganization of Government departments. Acting upon the recommendation of its Committee on Public Affairs, it will not concern itself with the general reorganization activities of the Government but will confine itself to promoting a nation-wide movement for the establishment of a National Department of Public Works. It is felt that the membership of the Federation can be of greatest service to the nation by confining their efforts to public matters closely related to the engineering profession.

The organization and equipment of the National Public Works Department Association has been taken over by the American Engineering Council and state organizations will assist in the program. At a meeting of the Council to be held in St. Louis on June 3 a detailed plan for renewing the public works campaign in every state will be considered.

Many leading industries, universities and technical organizations are represented in the national organization. Among the educators are Dean George B. Pegram of Columbia; Professors George F. Swain of Harvard, W. B. Gregory of Tulane, T. U. Taylor, University of Texas, J. W. Votey, University of Vermont, W. H. Kenerson of Brown, and C. E. Condra, University of Nebraska, and Dean John H. Dorroh, University of Mississippi.

At a hearing before the Senate Committee on Education and Labor early in May, Mr. Wallace, speaking in behalf of the F.A.E.S. and of the National Public Works Department Association, proposed joint consideration with the public works plan and suggested that modifications be made in the bill for the establishment of a Department of Public Welfare.

Mr. Wallace stated that the Federation does not take a definite stand either for or against the establishment of a Department of Public Welfare, but does urge the vital necessity of a proper distribution of bureaus if Government reorganization is to be effected. The Federation advocates that all the major engineering, construction and research work of the Federal Government be centered in a Department of Public Works, to supersede the Department of the Interior. Other bureaus now in the Department of the Interior must therefore be placed in other departments. Inasmuch as the provisions of the bill for the Department of Public Welfare which is under consideration by the Senate Committee provides for a number of such bureaus and activities, the Federation believes that the bill should be so modified as properly to assign those bureaus that would not be included in the proposed Department of Public Welfare.

Among the bureaus which the McCormick bill, which provides a Department of Public Welfare and a Department of Public Works, would place under the jurisdiction of the latter department, are the General Land Office, the Geological Survey, the Bureau of Mines, the Reclamation Service, the National Park Service, the Division of Capitol Buildings and Grounds, and the Alaskan Engineering Commission.

Licensing of Engineers Exciting Widespread Interest

Interest in the subject of licensing or registering of architects, engineers and land surveyors has become widespread and persistent. Eleven states have passed laws, some providing for licensing of all three professions, some for only one or two of them. These are Colorado, Florida, Idaho, Illinois, Iowa, Louisiana, Michigan, New York, Oregon, Virginia and Wyoming.

In New York the law passed May 14, 1920, has been amended by recent legislation to make it more workable. When these amendments were being considered at a hearing before the State Board for Licensing Professional Engineers, the Department of Education and the Senate Judiciary Committee in February, it was proposed by a group of engineers to further amend the law by eliminating the clause exempting corporations and partnerships from the necessity of being licensed. It was argued that lawyers and doctors cannot incorporate to practice their professions and that engineers ought to be on the same basis. The elimination of the clause was strongly opposed by a second group of engineers and the bill as finally signed by the Governor on May 6 retains it.

The clause in the New York State law is in effect Section 14 of the Recommended Uniform Law for Registration of Architects, Engineers and Land Surveyors, drawn up in 1919 by a committee of Engineering Council. This clause states that "a corporation or partnership may engage in the practice of architecture, engineering, or land surveying provided the person or persons connected with such corporation or partnership in responsible charge of such practice is or are registered as herein required of architects, engineers and land surveyors, or is or are otherwise authorized to practice."

The New York State Engineers' License Bill (now Chapter 581, laws of 1921) took effect upon the date the Governor affixed his signature. All engineers practicing in the State must be registered before May 1922, no matter what branch of engineering they are following.

A printers' strike in Albany has held up the distribution of copies of the bill and of application blanks. Persons who desire blanks should, however, write immediately to the Bureau of Education, Albany, N. Y., and request that their names be placed on file. They will then receive applications blanks as soon as they are available.

At a meeting of the Executive Board of the American Engineering Council on April 16 a representative of those who object to exempting corporations from the necessity of being licensed asked to have this "Model Bill" of Engineering Council referred to a special committee for revision with respect to reconsideration of the rights of engineers to practice their profession through partnerships and corporations. The Executive Board decided to do this, but considered the Licensing Committee which drew up the "Model Bill" a more appropriate body than a new special committee to take under consideration both sides of this important question.

Formation of the Personnel Research Federation

The formation of the Personnel Research Federation under the auspices of the National Research Council and Engineering Foundation links together 250 scientific, engineering, labor, management and educational bodies for the purpose of bringing about interchange of research information about men and women in industry and commerce, encouraging research through individuals and organizations, and coördinating research activities on a nation-wide scale. It aims to increase the efficiency of all the personnel elements of industry—employer, manager, worker—and to improve safety, health, comfort and relationships. Its immediate purposes will be to learn what organizations are studying one or more problems relating to personnel and the scope of their endeavors, and to determine whether these endeavors can be harmonized, duplication minimized, neglected phases of the problems considered, and advanced work undertaken.

Robert M. Yerkes, representing the National Research Council, has been elected chairman of the Federation, and Samuel Gompers, representing the American Federation of Labor, vice-chairman. Robert W. Bruere, who represents the Bureau of Industrial Research, was chosen treasurer, and Alfred D. Flinn, representing Engineering Foundation, secretary. Beardsley Ruml, assistant to the president of the Carnegie Corporation of New York, was selected as acting director.

Dr. James R. Angell, president of Yale University and past-chairman of the National Research Council, in an address delivered before the preliminary conference at Washington in November 1920, summarized in the following words the kinds of problems which should receive attention from the organization then proposed:

> Certain of the hygienic problems of modern industry exemplify cases in which a thoroughly scientific study of causes and effects is possible with convincing conclusions regarding practice which will safeguard the health and vigor of all concerned. Not a few highly important results have already been attained in this field. The effects upon industrial productivity on the one hand, and physical vitality on the other, of good and bad ventilation, of good and bad light, of high temperatures, of irritant fumes, of dust and other similar features are, theoretically, at least, within the field of scientific analysis and the ascertainment of demonstrable fact. Similarly, and in a different zone of inquiry, it should be possible to secure thoroughly reliable data regarding the dominant causes of unrest in our industries, of excessive turnover and the like. Many other instances of the same kind will suggest themselves to all who have experience in the industrial field.

U. S. Patent Office Relief Imperative

In an address before the Washington Section of the A.S.M.E. on April 28, Hon. Thomas E. Robertson, U. S. Commissioner of Patents, gave statistics showing the serious situation existing in the Patent Office because of the low salary scale which is causing an exodus of both patent examiners and clerical force to private employment. In a little over a year, it was stated, 110 of the force of examiners numbering 437 have resigned. During the first three weeks of March six highly trained experts resigned to accept outside positions offering salaries two or three times as great as those they were receiving in the Patent Office. In the past year, according to Commissioner Robertson's figures, 142 of the 560 clerical workers have left the service. There are thirty clerks in the Patent Office who receive only $720 a year; under the new salary bill they would receive $1100.

The immense amount of work turned out yearly by the Patent Office was also shown by the Commissioner's statistics. The stock of the Office is about 75,000,000 copies of some 1,500,000 patents, and new patents at the rate of from 600 to 1000 a week add 50,000 more copies to be taken care of each week. There is a stenographic department handling legal work that turned out 13,000,000 words in the past year and brought $62,000 revenue.

Major Amasa M. Holcombe, formerly chief of Patent Section, General Staff, U.S.A., speaking at the same meeting, said that patents play an increasingly important part in proportion to the degree of specialization in industry. He stated that abuse of the patent laws is partly due to the failure of business men and engineers to appreciate and utilize patents. Both speakers urged that engineers aid the present patent legislation.

Mr. E. J. Prindle, chairman of the Patents Committee of the American Engineering Council, in a recent statement said that it was the unqualified opinion of the important engineering, research and manufacturing associations of the United States that the scientific and industrial interests of the country are being jeopardized by Patent Office conditions. The National Research Council, the American Chemical Society, and the National Association of Manufacturers were cited by him as among the organizations favoring Patent Office relief. "The European countries, taught by the war," he said, "are already strengthening their patent systems. America must not lag."

In connection with American patents in Europe, American Engineering Council announces the organization of a Foreign Relations Committee with L. B. Stillwell of New York as chairman. Discrimination against American patents in Europe ceased with the passage of the Nolan Treaty Patent Bill on March 3, and American inventors are therefore no longer at a disadvantage in foreign countries because of the lack of proper legislation.

American Engineering Council urges again that the engineers of the country support the pending patent legislation to increase salaries in the United States Patent Office.

Fred M. Feiker, vice-president and chairman of the editorial board of the McGraw-Hill Company, who has been active in the formation of the F.A.E.S. and of great assistance in the development of the plan for the elimination of waste in industry, has been appointed personal assistant to Secretary Hoover in the task of organizing and developing those branches of the Department of Commerce which relate directly to commerce and industry.

Alcohol as Automobile Fuel

It is stated in a recent issue of *Commerce Reports* that pure alcohol of from 41 to 42 degrees has been found to answer the requirements of automobile motors satisfactorily, with but a slight alteration in the carburetor and the substitution of metal floaters for the varnished cork floaters which are attacked by the alcohol. The amount of alcohol consumed is said to be practically the same as the amount of gasoline which would be consumed for the same work. A distinct advantage in the use of alcohol is that its combustion is much more complete, and therefore very little carbonized matter is deposited in the combustion chamber or ejected through the exhaust.

A Correction

In the May issue of MECHANICAL ENGINEERING, page 351, reference was made to a paper on Developments in Organizing Personal Relationships in Industry presented at the March 25th meeting of the New York Section of the A.I.E.E. and the Metropolitan Section of the A.S.M.E. by Mr. L. P. Alford, editor of *Management Engineering*. Mr. E. W. Tree, associate editor of *Management Engineering*, whose name was inadvertently omitted, was co-author with Mr. Alford.

Engineering and Industrial Standardization

The A.E.S.C. Issues First Annual Report

IN THE form of an attractively printed pamphlet the American Engineering Standards Committee has just issued its first Annual Report outlining the Committee's progress during 1920.

Although the A.E.S.C. has been actively at work for only slightly more than a year, and much of the time and effort of the Committee has necessarily been spent in laying a basis for work the fruition of which will require at least two or three years, yet considerable progress has already been made in the unification of the more important standards and in overcoming the confusion that was being produced by the numerous organizations (more than 100) that hitherto published engineering standards without systematic coöperation among themselves.

Prior to December 31, 1920, there had been approved by the Committee "Tentative American Standard Specifications and Tests for Portland Cement," "Tentative American Standard Specifications for Fire Tests of Materials and Construction," and "American Standard Pipe Threads." Moreover, there had been submitted for approval by the Committee the "National Electrical Code" as an American Standard, and "Standard Test for Toughness of Rock," "Standard Method of Distillation of Bituminous Materials for Road Treatment," and "Standard Method of Sampling Coal," as Tentative American Standards, with the "Safety Code for Head and Eye Protection" submitted for approval as Recommended American Practice.

The Committee itself is now composed of 47 members representing 17 bodies or groups of bodies, including six national engineering societies, five governmental departments and 13 national industrial associations. As is generally known, its function is merely to see that each body or group interested in a standard shall have opportunity to participate in its formulation, which is in the hands of a working committee, technically called a "Sectional Committee." Each Sectional Committee is organized by, and under the leadership of, one or more of the principal bodies interested, such bodies being known as "Sponsors." Sponsorships have been arranged for the following projects under way by the beginning of this year:

Electrical Projects: Rating of Electrical Machinery; Term Markings for Electrical Apparatus

Mechanical Projects: Ball Bearings; Plain Limit Gages; Gears; Machine-Tool Elements; Nut and Bolt Heads; Pipe Flanges and Fittings; Screw Threads; Shafting

General Projects: Passenger and Freight Elevators; Color Scheme for Piping Installations; Steel Shapes; Zinc Ores and Zinc

Safety Codes: Aviation Safety Code; Construction Work; Electrical Fire Code; Electrical Safety Code; Floor Openings; Railings and Toe Boards; Foundries; Gas Safety Code; Grinding Wheels; Head and Eye Protection; Ladder Code; Lighting Code, Lightning Protection; Logging Operations and Sawmill Machinery; Machine Tools; Mechanical Transmission of Power; Paper and Pulp Mills; Electrical Power Control; Power Presses; Mechanical Refrigeration; Industrial Sanitation; Stairways, Fire Escapes and Other Exits; Textiles; Ventilation; and Woodworking Machinery.

As will be seen from the above lists, much of the Committee's attention is given to safety codes. Active work is now in progress on 24 such codes with hearty coöperation among the state commissions, associations of insurance companies, national engineering societies, manufacturers' and industrial associations, labor and civic organizations, and technical bureaus of the Federal Government. As is true of all work under the auspices of the American Engineering Standards Committee, such of the bodies as are interested in a particular code are represented in the committees responsible for the formulation of that code.

Copies of the report may be obtained on request to the American Engineering Standards Committee, 29 West 39th St., New York.

Japan Adopts the Metric System

In Comptes Rendus des Séances de l'Académie des Sciences for March 29, 1921, pages 795–796, reference is made to a telegram from Shirio Kikkawa, director of the Bureau of Weights and Measures of Tokyo, stating that in a recent session of the Japanese Parliament a law was passed making the use of the metric system obligatory in Japan. Since 1893 the metric system has been in "legal use" in Japan, but in practice its adoption has been greatly retarded by the prevalence of the local systems. The 1893 law giving the legal sanction to the metric system contained a series of suggestions and recommendations for the gradual substitution of the local units for the metric units. The new law makes the metric system compulsory in the Japanese Empire.

As regards other countries of the Far East, a provisional project for the obligatory adoption of the metric system was introduced in the Chinese Parliament in 1913 with a provision that the system would become officially the only system of measures in China within ten years, and similar projects have been enacted in Siam.

A.S.M.E. Presents Resolution of Thanks to Henry Hess

At a meeting of the Philadelphia Local Section held at the Philadelphia Engineers' Club on April 26, Henry Hess was presented with an engrossed copy of the following resolution of appreciation of the services rendered by him in the cause of standardization:

> The President and Council of The American Society of Mechanical Engineers by resolution gratefully acknowledge the service rendered to the cause of standardization by Henry Hess, who was one of the first to foresee the advantages that would accrue from the coöperation of manufacturers, consumers, and technical societies in standardization work, and who has been tireless in his efforts to bring about such coöperation in engineering standardization in this country.
>
> His foresight and devotion to the cause have been largely responsible for the broad principles now being followed by the American Engineering Standardization Committee, which is so successfully coördinating and directing the work of the various organizations engaged in engineering standardization.

Mr. Hess became a member of this Society in 1906. He was manager for the years 1911–1914 and vice-president for the period 1914–1916. He attended the meeting in person and received the resolution from D. Robert Yarnall, who made the presentation address.

Dr. Edward B. Rosa Dies

Dr. Edward Bennett Rosa, chief physicist of the United States Bureau of Standards, died suddenly in his office in the Bureau on May 17. Dr. Rosa had done notable work in the scientific field, particularly in electrical research. He was born in Rogersville, N. Y., on October 4, 1861. After graduation from Wesleyan University in 1886 he entered Johns Hopkins University where he later received the degree of Doctor of Philosophy. He served for short periods as instructor in the University of Wisconsin and as professor of physics at Wesleyan, and in 1901 became chief physicist of the Bureau of Standards.

Dr. Rosa developed the physical side of the respiration calorimeter and with Dr. Dorsey as collaborator in 1907 began work on the determination of the ampere which has now been perfected until it is possible to define this unit satisfactorily. His collection of known formulas for computing induction is known widely as a model. Another of Dr. Rosa's achievements was to establish definitely the laws governing electrolytic corrosion. During the war he developed a sound-ranging device for locating big guns, and the geophone for detecting mining operations. He also interested himself in the development of aircraft radio apparatus and improved the radio direction finders by which enemy ships and aircraft could be located. Under his direction the Bureau of Standards has established what is perhaps the finest radio research laboratory in the country.

He was a member of many scientific societies, among them being the International Commission of Electric Units and Standards, of which he was secretary, the National Academy of Sciences, the American Philosophical Society, the American Association for the Advancement of Science, the American Institute of Electrical Engineers, the American Physical Society, the Illuminating Engineering Society, the Société Française de Physique, the Washington Academy of Sciences, and the Philosophical Society of Washington.

NEWS OF OTHER SOCIETIES

Society of Industrial Engineers

Spring Meeting in Milwaukee on April 27, 28 and 29. Industrial leadership was the subject for discussion. The speakers emphasized the need for increasing attention to public matters in directing the affairs of industry. This was particularly stressed by L. W. Wallace, executive secretary of the American Engineering Council, who in his presidential address insisted that the industrial leader who does not concern himself with the social, political and economic life of his community is a failure. Turning to industrial problems in the United States, Mr. Wallace believed that the question of production should be considered as a whole rather than from the standpoint of the individual plant. He attributed the dissatisfaction of labor to the alternating phases in industry of intense activity and blighting stagnation. The antidote does not lie, he said, in an indiscriminate reduction of wages, but in regulating production and distribution economically.

Chester B. Lord, works manager, Advance-Rumely Co., Battle Creek, Mich., in Methods of Determining a Fair Day's Work and a Fair Day's Pay, related processes by which fatigue had been eliminated in his plant. In some experiments performed with a view to introducing rhythmic sequence, punch presses were taken which were used for blanking small armature disks continuously. The presses ran at 200 r.p.m. and had a 2-in. stroke. As the production of each press averaged between 35,000 and 40,000 pieces per day the man operating it had to stand on one foot or rest his weight on one side of his stool and trip a lever 35,000 times per day, moving his hands in synchronism. The stroke of one of the presses was reduced to $^3/_4$ in. and the speed coincidently lowered to 100 r.p.m. The result was that instead of from 80 to 85 blanks an average of 90 was secured per minute, noise and the wear and tear of the machine were sensibly reduced, and the efforts of the operator were diminished because he moved his work in rhythm with the press and no longer had to trip it. Similar studies were made of the operation of drill presses by women. In this instance the presses were altered so that the spindles would reciprocate automatically and in synchronism, and the speeds were adjusted to the requirements of the motion.

The educational requirements of a plant executive were discussed by S. E. Stout, betterment manager, Whiting Corporation, Harvey, Ill. The graduate, he said, should have had included in his schooling a definite class of industrial work, such as engineering, accounting, production, etc., which would prepare him for a definite class of positions; but no industry can expect colleges to train men for its own peculiar need. On the other hand, the graduate who knows a little of everything, but nothing in particular, is of no special value to any industry.

Standardization of products was urged both as an aid to production and as a necessary requirement to compete successfully with foreign manufacturers. Commenting on papers which treated this subject, President Wallace observed that whereas the national engineering societies of mechanical, electrical, mining and civil engineers are spending $50,000 a year for the working out of engineering standards in Europe, where a keen competition for industrial supremacy exists among the nations, the governments are appropriating hundreds of thousands of dollars for the same kind of research.

American Electrochemical Society

General meeting at Atlantic City, N. J., on April 21, 22 and 23. A symposium on corrosion and professional papers on electric arc welding, electric furnaces and electric-furnace problems in the steel and non-ferrous industries, and on electrolytic nickel were the technical arrangements of the program. Corrosion was discussed under four aspects: atmospheric corrosion; corrosion by water; chemical or acid corrosion; and electrochemical corrosion. Professor W. H. Walker, of the Massachusetts Institute of Technology, strongly advocated the corrosion-resisting ability of copper-bearing steel. The superior quality in this respect of pure commercial iron was maintained in a written discussion by J. A. Aupperle, chief chemist, American Rolling Mill Co., Middletown, Ohio. The argument for copper-bearing steel was supported by D. M. Buck, metallurgical engineer, American Sheet & Tin Plate Co., Pittsburgh, who presented additional evidence in confirmation of his theory that the alloy of copper and iron is less electropositive to the film of rust formed than is non-copper steel and the consequent decrease in difference of potential lessens the corrosion.

Practical Means of Preventing Corrosion of Iron and Steel Where Not Exposed Directly to the Atmosphere, was the title of a paper presented by F. N. Speller, metallurgical engineer, National Tube Co., Pittsburgh. Mr. Speller gave practical illustrations of "deactivating" apparatus for removing the oxygen in hot-water systems and spoke of the unusual beneficial results obtained. Boiler-tube corrosion was discussed by B. G. Worth, vice-president, Walter Kidde & Co., New York. Another paper by J. A. Aupperle and D. M. Strickland, both connected with the American Rolling Mill Co., Middletown, Ohio, dealt with acid corrosion. It presented a record of tests on pure iron made in open-hearth furnaces, copper iron, plain steel and copper steel to determine their resistance to corrosion by sulphuric acid. In all cases cited pure iron made in open-hearth furnaces had the smallest corrosion. A plea for the intelligent use of metallography and metallurgical principles in attempts to find non-corrodible alloys was made by Oliver P. Watts, associate professor of chemical engineering, University of Wisconsin, Madison, Wis.

Three papers were submitted treating of non-ferrous corrosion. In the first, Dr. John F. Thompson, manager technical department, International Nickel Co., enumerated the anti-corrosive properties of monel metal under varying conditions. Henry S. Rawdon, of the United States Bureau of Standards, discussed examples of interior corrosion of certain brasses, muntz metal particularly, where in many instances a dezincification takes place, resulting in a breaking down of the alloy. The third paper was on the Electrolytic Corrosion of Lead by Continuous and Periodic Currents, by E. R. Shepard, electrical engineer, United States Bureau of Standards.

Dr. Colin G. Fink, who acted as chairman at the sessions of the symposium, summarized the main points brought out. According to Dr. Fink the following facts were established: (1) That iron or steel containing about 0.25 per cent copper is anti-corrosive under most atmospheric conditions; (2) that iron or steel containing about 0.25 per cent copper when immersed in tap water or acidulated media does not endure as well as commercially pure iron; (3) oxygen in boiler or hot-water systems accelerates corrosion, but this influence is removable by extracting the oxygen; (4) corrosion is caused by carbon dioxide in boiler water containing soluble iron, but this condition can be corrected; (5) chromium, nickel and silicon added to iron tend to reduce corrosion; and (6) special steel and other alloys reduce corrosion possibilities, but a coördination of results is still lacking.

The list of professional papers on other subjects included the following: Phenomena of Arc Welding, by O. H. Eschholz; Electrodynamic Forces in Electric Furnaces, by Dr. Carl Hering; Recent Progress in High-Frequency Induction Heating, by E. F. Northrup; and Regulation of Electric Steel Arc Furnaces Using Movable Electrodes, by W. G. Mylins.

American Gear Manufacturers' Association

Convention at Cincinnati, on April 27–30. The reports from seven committees indicated that substantial progress has been made during the year in the standardization of gears. The Association and The American Society of Mechanical Engineers have been for some time working jointly for the formulation of standards which will be recognized as the United States standards. The recommendations of the various committees were discussed at great length and a number of them were adopted by the convention, while many others were referred back to the committees for further investigation. From the report of the spur-gear committee, for example, the following clauses were approved: The width of face for industrial spur gearing shall be 10 divided by the diametral pitch; the thickness of rim for spoked spur gears for industrial work shall be 4 divided by the diametral pitch, or 1.3 times the circular pitch; the diameter of hub for spoked spur gears for industrial work shall be 2 times the diameter of bore.

In a paper on The Ideal Chain and Sprocket Drive, G. M. Bartlett, Diamond Chain & Mfg. Co., Indianapolis, referred to the work of the committee on standardization of The American Society of Mechanical Engineers on steel roller chains, and that of the roller chain division of the Society of Automotive Engineers on the same subject. This work is now being done coöperatively by the two committees. British chain makers have also organized and have standardized to a great extent, and where differences occur they are not sufficiently great to prevent American chains from operating over British sprockets.

Erik Oberg, editor of *Machinery*, one of the committee of editors of technical magazines that recently conferred with Secretary Hoover of the Department of Commerce, conveyed the message from the secretary as to what the department aims to accomplish in the way of helping industry, and the assistance which it would like to secure from industrial associations in the way of furnishing statistics of the respective industries. The association went on record as favoring the assistance of the Department of Commerce as far as possible.

This report has been prepared from the extensive account of the convention published in *Iron Age* for May 5.

National Metal Trades Association

Annual meeting in New York on April 20 and 21. The belief was expressed that the worst of after-war industrial difficulties have passed, but complete recovery of business was not expected to take place this year. The outcome of recent conflicts between employers and union workers, it was thought, had demonstrated the soundness of the principle of the open shop.

A progress report was presented by the committee on industrial education. As a result of their studies during the year, the committee find that: (1) There is a shortage of efficient workers for normal production; (2) too few companies train workers; (3) many of those who do attempt to train have nothing even approximating a definite schedule for this work, and have not definitely determined responsibility for instruction and training as part of the duties of some person or group; (4) very few foremen are able to give proper instructions in the training necessary; (5) conditions within the various plants determine the type of training necessary. They offer the following recommendations: (1) That a definite number of specialists or apprentices be trained in each shop, this number to be proportionate to the total number employed; (2) that a committee on industrial education and training be formed in each branch, such committee to coöperate with local educational or training institutions on questions pertaining to technical, vocational, part-time and continuation schools, and to consider ways and means of furthering training and education within the plants of members of the association.

George A. Seyler, works manager, Lunkenheimer Co., related his experience in installing a training department. In planning and selecting a location the decision was reached to isolate the training department from the production departments. By this arrangement it was intended to prevent any confusion arising in the beginner's mind from comparing himself with trained workers. A director of training and several assistants are always on hand to give information and help to the apprentices. The training course lasts two weeks. As to how the students qualify in comparison with men trained under the old method, the foremen have reported that the students at the time of entering are equal to men who have been working in the shop from six to nine months.

The methods pursued by the University of Cincinnati in training instructor foremen were outlined by D. J. McDonald, professor of vocational education at that university. W. C. Wilson of the American Institute of Weights and Measures, New York, spoke briefly on the Britton bill, which was introduced in the House of Representatives on April 11 "to fix the metric system of weights and measures as the single standard of weights and measures for certain uses."

Further particulars of this meeting may be found in *Iron Age* for April 28.

LIBRARY NOTES AND BOOK REVIEWS

ALUMINIUM. By George Mortimer. Sir Isaac Pitman & Sons, Ltd., London and New York. (Pitman's common commodities and industries.) Cloth, 5 × 7 in., 152 pp., illus., tables, $1.

This little book gives a clear description, suited to the needs of lay readers and business men, of the processes by which aluminium is made and of its uses in industry, particularly in automobile and aircraft construction, the chemical industry, electro and electrical engineering.

CAM DESIGN AND MANUFACTURE. By F. B. Jacobs. D. Van Nostrand Co., New York, 1921. Cloth, 6 × 9 in., 121 pp., illus., $2.

This book is intended for machine designers and cam makers, as a practical aid in laying out and cutting cams. The writer has avoided mathematical formulas.

CHILTON TRACTOR INDEX. Vol. 4, No. 1. Chilton Co., Philadelphia, 1921. Paper, 7 × 10 in., 456 pp., illus., tables, $2.

This semi-annual handbook is a reference book for those interested in tractors and farm-power machinery. It includes a directory of manufacturers of tractors, specifications of those on the market, with illustration, of most of them, a directory of manufacturers of farm-power machinery, electric plants, motor trucks, etc., and a list of makers of tractor parts and equipment. General articles and tables of data valuable to makers and users are also included.

COST ACCOUNTING TO AID PRODUCTION. By G. Charter Harrison. The Engineering Magazine Co., New York, 1921. Cloth, 6 × 9 in., 234 pp., plates, $7.50

The author of this volume believes that the customary methods of cost accounting are entirely unsuited to the needs of modern industry. Cost accounting, in his opinion, should not be a compilation of information concerning past events, but a method of predetermining costs. His book discusses the proper functions of an accounting system, and how to secure them, but is chiefly intended to stimulate thought and provoke discussion of the subject.

THE ELECTRIFICATION OF RAILWAYS. By H. F. Trewman. Sir Isaac Pitman & Sons, Ltd., London, 1920. (Pitman's technical primer series.) Boards, 4 × 7 in., 78 pp., diagrams, $1.

This little volume is an outcome of the discussions as to the advisability or otherwise of electrifying the railroads of Great Britian, a subject of general interest because of the necessity for relieving railway congestion and utilizing coal in the most economical manner. Without going into technical details covered in books on electric traction, the author brings forward the commercial aspect of the matter and calls attention to some of the main questions to which attention must be paid. Sufficient electrical information is given to enable these points to be understood by readers who are not electricians.

ÉLEMENTS DE MECANIQUE Á L'USAGE DES INGENIEURS: RESISTANCE DES MATERIAUX. By Robert d'Adhémar. Gauthier-Villars et Cie Paris, 1921. Paper, 6 × 9 in., 185 pp., diagrams.

In writing this book the author has attempted an introduction to the theory of the resistance of materials, in which the hypotheses that have been adopted to simplify the subject in practice are set forth as briefly and simply as is possible.

ERGEBNISSE DER AERODYNAMISCHEN VERSUCHSANSTALT ZU GOTTINGEN. By L. Prandtl. Part 1. R. Oldenbourg, München und Berlin, 1921. Paper, 8 × 11 in., 140 pp., plans, illus., tables, 40 marks.

This publication, the first of a series of bulletins devoted to the experimental investigations undertaken by this research laboratory, gives the hitherto unpublished results of recent researches. These are chiefly concerned with the shapes and profiles of propeller blades, although minor investigations of the reciprocal ef-

fect of wings and propellers and bodies and propellers and of the frictional resistance of wing fabrics are included. The bulletin gives results of tests of almost all the blade forms that have been used or investigated in Germany during recent years. The work also describes the organization, equipment and methods of the laboratory, and a summary introduction to the theory of air resistance, including the new theory of flight.

Fire Tests of Building Columns by Associated Factory Mutual Fire Insurance Companies, the National Board of Fire Underwriters, and the Bureau of Standards, jointly conducted at Underwriters' Laboratories, Chicago, 1917–1919. Cloth, 6 × 9 in., 388 pp., illus., charts, tables; $2.50.

This pamphlet presents the results of an investigation undertaken to ascertain the ultimate resistance against fire of protected and unprotected columns as used in the interior of buildings, and their resistance against impact and sudden cooling from hose streams when highly heated. The results of 91 fire and 15 fire and water tests are given, including tests of representative types of steel, cast iron, concrete-filled pipe and timber columns, protected and unprotected, and reinforced-concrete columns. It is stated to be the most complete investigation ever made.

Foundry Moulding Machines and Pattern Equipment. By Edwin S. Carman. Second edition. Cloth, 6 × 9 in., 225 pp., illus.

Contents: general moulding principles; the theory of jolt ramming; roll over jolt moulding machines; roll over jolt moulding machines for large-size, medium-size and small-size rolls; jolt moulding machines in brass and aluminum foundries; plain jolt moulding machines; air-operated squeezer machines; jolt stripper moulding machines; pattern equipment; flask equipment; machine moulded cores; foundations for jolt ramming moulding machines.

As shown by its contents, this book is intended to explain the construction of moulding machines and their use for various kinds of molds. The methods of pattern mounting and moulding are described in detail and very fully illustrated by photographs.

Gas Torch and Thermit Welding. By Ethan Viall. First edition. McGraw-Hill Book Co., Inc., New York, 1921. Cloth, 6 × 9 in., 442 pp., illus., $4.

This is a careful summary of American practice and equipment, selected from the existing literature, from shop data, and from the experience of experts. The materials and apparatus used, the methods and their application to particular kinds of work, are described in detail, providing a large amount of practical information for workmen and engineers.

Gasoline Automobiles. By James A. Moyer. First edition. McGraw-Hill Book Co., Inc., New York, 1921. Cloth, 5 × 8 in., 261 pp., illus., $2.

The purpose of this book is to present clearly, briefly and interestingly, the essential principles of automobile construction. It is expected to furnish practical help to drivers who wish to know the causes of ordinary operating troubles and the ways to remedy them.

Herbert Hoover, the Man and His Work. By Vernon Kellogg. D. Appleton and Co., New York, 1920. Cloth, 5 × 8 in., 375 pp., portraits, $2.

Dr. Kellogg's book is the attempt of an observer, associate and friend to tell, simply and straightforwardly, the personal story of the man and his work up to the present. His boyhood, education, work in Australia, China and London are recounted briefly, and much space given to his work for the relief of Belgium, as food and relief administrator. As appendixes are given four important addresses by Mr. Hoover.

Human Engineering, a Study of the Management of Human Forces in Industry. By Eugene Wera. D. Appleton & Co., New York, 1921. Cloth, 5 × 8 in., 378 pp., $3.50.

This volume is a contribution to the discussion of the relationship of labor, capital and society in the industrial development of the world. Neither the old nor the modern school of management has succeeded in removing labor unrest, owing, in the author's opinion, to the ignoring of labor as a social group and disregard of the social purpose of industry. To present the principle of stimulating labor as a whole toward production at large for social purposes is the object of the present work.

The author studies the evolution of the ideas governing industrial relations, interprets the essentials of present issues, presents certain democratic tendencies and develops a typical organization for class coöperation. Other sections analyze the different psychological associations of men involved in industry, discuss the principles of human engineering and outline their application.

Marine and Stationary Engines. By A. H. Goldingham. Second edition, revised and enlarged. Spon and Chamberlain, New York, 1921. Cloth, 5 × 8 in., 233 pp., illus., plates, tables, $3.15.

This treatise is offered to designers and operators in need of concise, practical information on the various types and designs of Diesel engines. The book opens with a brief account of the theory of the engine. This is followed by a description of the details of construction, and discussions of indicator diagrams, of the advantages and disadvantages of Diesel engines, and of their operation and maintenance. These general topics are followed by descriptions and drawings of many types of engines.

The Mariners' Handbook. By International Correspondence Schools. Third edition. International Textbook Co., Scranton, Pa., 1920. Cloth, 4 × 5 in., 495 pp. plates, illus., $1.50.

A small pocketbook of information on nautical matters, intended for young men in the naval and merchant marine service, and for laymen interested in nautical affairs. Although the treatment is brief, it is sufficient for ordinary reference purposes.

Metallography. By Samuel L. Hoyt. Part 2, The Metals and Common Alloys. First edition. McGraw-Hill Book Co., Inc., New York, 1921. Cloth, 6 × 9 in., 462 pp., illus., tables, $5.

The second volume of this treatise on metallography describes the more important metals and alloys. This description includes the constitution and microstructure, the physical and mechanical properties for different heat and mechanical treatments, the effects of the common impurities and a brief discussion of the uses. Those compositions of particular importance have been treated in more detail and measured values of their important properties are included.

Modern Pulp and Paper Making. A Practical Treatise. By G. S. Witham, Sr. Book Dept., The Chemical Catalog Co., Inc., New York, 1920. Cloth, 6 × 9 in., 599 pp., illus., tables, $6.

This treatise is the work of a writer with long practical experience in the industry, and is intended to fill the need for a practical work on paper manufacture as carried on in America. It is not too abstruse and technical for the average papermaker, but is thorough enough to be of real value. The book describes the equipment and processes in actual use, and also treats of plant design and personnel.

Neue Grundlagen der Technischen Hydrodynamik. By L. W. Weil. R. Oldenbourg, Munich and Berlin, 1920. Paper, 6 × 9 in., 219 pp. illus., diagrams, 26 M.

This work is concerned with some of the problems of hydrodynamics, for which no exact elucidation or analytical solution has yet been obtained, as, for example, eddies in streams and pipes, the effect of expansions or contractions in channels, orifice problems, water hammer and the theory of turbines and of rotary flow of liquids. The author advances certain principles, based on long theoretical and practical study, which he considers correct and in accordance with experimental results.

The New Thermodynamics; the non-postulated rationale of motive power of heat. By Jacob T. Wainwright. Privately printed, 1921. Boards, 7 × 10 in., 44 pp.

Believing that the second law of thermodynamics, which is the foundation for present-day teaching of that branch of thermodynamics which treats of the motive power of heat, is untrue, the author presents his arguments for its repudiation. The monograph sets forth his views as to the rationale of the motive power of heat and his grounds for claiming that the Carnot principle conflicts with the principle of the conservation of energy and with observed results.

Patent Law. By John Barker Waite. Princeton University Press, Princeton, N. J., 1920. Cloth, 6 × 9 in., 316 pp., $5.

In this volume the professor of law in the University of Michigan Law School presents a concise but complete and thorough discussion and exposition of the principles of patent law, intended for inventors, engineers and all that class of laymen who from time

to time want information concerning their rights in respect to patents and inventions. It purports to cover only the substantive law of patents, their nature, validity, effect and their characteristics as property; and the author has attempted to present every issue that has come before the courts.

PATTERNMAKING. By Ben Shaw and James Edgar. Sir Isaac Pitman & Sons, Ltd., London and New York, 1921. (Pitman's Technical Primer Series.) Boards, 4 × 7 in., 108 pp., illus., $1.

This little volume gives a birdseye view of the subject, for use by students, apprentices, young journeymen and others who wish some knowledge of the principles that underly it.

PRODUCER GAS. By J. Emerson Dowson and A. T. Larter. Fourth edition. Longmans, Green and Co., New York, 1920. Cloth, 6 × 9 in., 361 pp., illus., $7.50

Contents: Theory of producer gas; furnace work; heating work; engine work; suction plants; gas from bituminous coal for engine work; producer gas from peat; gas traction on roads; gas propulsion of vessels; stand-by losses; comparison of gas and steam power; fuel; analysis of fuel and of producer gas; calorific power of solid and gaseous fuels; practical notes. Appendices.

The table of contents shows the scope of this treatise, which gives a general survey of present practice in the production and utilization of producer gas. This edition has been thoroughly revised.

SPACE AND TIME IN CONTEMPORARY PHYSICS; AN INTRODUCTION TO THE THEORY OF RELATIVITY AND GRAVITATION. By Moritz Schlick. Rendered into English by Henry L. Brose. Oxford University Press, American Branch, New York, 1920. 10 + 89 pp., cloth, 6 × 9 in., $2.50.

The theory of relativity consists of two parts, the old special theory, and the more recent general theory. This book is intended as an introduction to the whole set of ideas contained in this theory and should interest especially those who are concerned with the general conceptions rather than the details. Its essential purpose is to describe these physical doctrines with particular reference to their philosophic significance. The present edition varies from the previous one only in minor improvements.

TASCHENBUCH FUR SCHIFFSINGENIEURE UND SEEMASCHINISTEN. By E. Ludwig and E. Linder. Third edition. R. Oldenbourg, Munich and Berlin, 1920. Cloth, 5 × 7 in., 514 pp., tables, diagrams, illus., 24 M.

This book is a third edition, under a new title and with new compilers, of G. Bauer's Kalender für Seemaschinisten. In its present form it is a volume of convenient size, intended for marine engineers, and covering concisely all the mechanical equipment of ships. The volume contains the necessary physical and mathematical tables and formulas, sections on reciprocating steam engines, steam turbines, turbine reducing gear, boilers, boiler accessories, piping, combustion engines, auxiliary mechanical equipment, electrical equipment, measuring instruments, ship construction, navigation, laws and regulations. All these subjects are treated from a modern point of view, particular attention being given to methods likely to be used in the future.

TECHNISCHER LITERATURKALENDER. Second edition. R. Oldenbourg, München-Berlin, 1920. Cloth, 6 × 8 in., 441 pp., frontispiece, 40 Marks.

This is a "Who's Who" of living German writers on technical subjects, compiled by the chief librarian of the German Patent Office. About seven thousand names are included. The information includes date of birth, address, education, occupation, writings and specialty. This edition contains a thousand names more than that of 1918, and has also an index by specialties and a list of deaths during 1918 and 1919.

THE TESTING OF MOTIVE-POWER ENGINES. By R. Royds. Second edition. Longmans, Green and Co., New York, 1920. Cloth, 6 × 9 in., 392 pp. diagrams, tables, $7.50.

This book is intended for students with an elementary knowledge of motive-power engineering, who desire information on the practical testing of motive-power engines. Special attention is given to the variable conditions under which a plant may operate and the necessity for systematic arrangements where a series of trials is contemplated. This edition has been revised and modified to meet modern developments.

A TEXT BOOK OF CHEMICAL ENGINEERING. By Edward Hart. The Chemical Publishing Co., Easton, Pa., 1920. Cloth, 6 × 9 in., 223 pp., illus., diagrams.

Contents: Materials; Location of Works; Boilers; Prime Movers; Plumbing; Crushing; Dissolving; Filtration; Tanks; Evaporation; Crystallization; Drying; Distillation; Absorption of Gases; Mixing and Kneading; Containers. The contents give an indication of the scope of Dr. Hart's new book, which is based upon his courses in Lafayette College. The treatment of the subject is brief and elementary, but thoroughly practical.

TEXT-BOOK OF THE MATERIALS OF ENGINEERING. By Herbert T. Moore. With a chapter on concrete, by H. F. Gonnerman. Second edition, first impression. McGraw-Hill Book Co., Inc., New York, 1920. Cloth, 6 × 9 in., 327 pp., illus., charts, tables, $3.

This text-book contains a concise presentation of the physical properties of the common materials used in structures and machines, together with brief descriptions of their manufacture and fabrication. It is primarily intended for use in connection with courses on the mechanics of materials, but the author hopes that it will also be useful to draftsmen, inspectors, machinists and others who use these materials. In this edition the chapter on concrete has been rewritten, a chapter added on rubber, leather and hemp rope, and other sections have been enlarged or revised.

THE THEORY OF MACHINES. By Robert F. McKay. Second edition. Edward Arnold, London, 1920. Cloth, 6 × 9 in., 448 pp., diagrams, $6.75.

Contents: Mechanics; Kinematics of Machines; Dynamics of Machines. Although many books exist which cover one or two special parts of this subject, the author believes this to be the first attempt at a systematic, comprehensive review of the whole. The volume is intended for students and engineers, many exercises being included for use by the former. This edition is practically identical with the first, only minor additions and alterations having been made.

THE VENTILATION HAND BOOK. By Charles L. Hibbard. Second edition, revised and enlarged. The Sheet Metal Publication Co., New York, 1920. Cloth, 6 × 8 in., 231 pp., illus., diagrams, $2.50.

This book is intended to present in convenient form, the principles of warm-air heating and ventilation, with simple methods for computing the sizes of the various parts of a system of this kind. The subject matter is arranged in the form of questions and answers, and the descriptions and mathematical data are given in very simple form.

THE WELDING ENCYCLOPEDIA. Compiled and edited by L. B. Mackenzie and H. S. Card. Welding Engineer Publishing Co., New York, 1921. Cloth, 6 × 9 in., 224 pp., illus., $5.

This book is a collection of information on oxy-acetylene, electric and thermite welding, arranged in concise alphabetical form for ready reference. The material has been largely selected from the files of the *Welding Engineer*, and is practical rather than theoretical in character.

WINNING THE PUBLIC. By S. M. Kennedy. First edition. McGraw-Hill Book Co., Inc., New York, 1920. Cloth, 6 × 9 in., 168 pp., port., $2.50.

This volume includes the substances of various addresses delivered before technical and trade associations during recent years. They discuss the relations of public utilities with those whom they serve and the methods by which public confidence and good will can be secured.

THE ENGINEERING INDEX

(*Registered U. S. Patent Office.*)

THE ENGINEERING INDEX presents each month, in conveniently classified form, items descriptive of the articles appearing in the current issues of the world's engineering and scientific press of particular interest to mechanical engineers. At the end of the year the monthly installments are combined along with items dealing with civil, electrical, mining and other branches of engineering, and published in book form, this annual volume having regularly appeared since 1906. In the preparation of the Index by the engineering staff of The American Society of Mechanical Engineers some 1200 technical publications received by the Engineering Societies Library (New York) are regularly reviewed, thus bringing the great resources of that library to the entire engineering profession.

Photostatic copies (white printing on a black background) of any of the articles listed in the Index may be obtained at a price of 25 cents per page, plus postage. A separate print is required for each page of the larger periodicals, but wherever possible two small or medium-sized pages will be photographed together on the same print. The bill will be mailed with the print. When ordering photostats identify the article by quoting from the Index item: (1) Title of article; (2) Name of periodical in which it appeared; (3) Volume, number, and date of publication of periodical; (4) Page numbers. Orders should be sent to the Engineering Societies Library, 29 West 39th Street, New York.

ACCIDENTS

Dust Explosions. Dust Explosions, Cause, Effect and Prevention. David J. Price. Eng. News-Rec., vol. 86, no. 15, April 14, 1921, pp. 634–636, 6 figs. Ignition and propagation of flame. Changes in construction to prevent high pressures from being built up within heavy concrete wall construction.

AERIAL PHOTOGRAPHY

Cameras. Eastman Kodak Aerial Cameras. Flight, vol. 13, no. 10, Mar. 10, 1921, pp. 167–168, 7 figs. Automatic types.

AERONAUTICS

Bureau of Naval Aeronautics. The Need of a Bureau of Naval Aeronautics. Aviation, vol. 10, no. 16, April 18, 1921, pp. 506–507. Suggests organization.

AEROPLANE ENGINES

B.M.W. The B.M.W. 6 Cyl. 185 Hp. Engine. Aviation, vol. 10, no. 12, Mar. 21, 1921, pp. 370–371, 1 fig. Characteristics: Number of cylinders, 6; bore, 5.906 in.; stroke, 7.086 in.; total piston displacement, 1,164.50 cu. in.

Constant-Compression. Aeroplane Engines Injecting Constant Mass of Fuel and Effecting Constant Compression at all Altitudes (Moteur d'aviation admettant une masse constante et effectuant une compression constant à toute altitude), M. A. Witz. Comptes rendus des Séances de l'Académie des Sciences, vol. 172, no. 11, Mar. 14, 1921, pp. 641–644. Possibilities of such motor for flight at high altitudes.

Developments. Army and Navy Development of Aero Engines. Aviation, vol. 10, no. 13, Mar. 28, 1921, pp. 390–391, 1 fig. Types of engines approved by Secretary of War and Secretary of Navy for development of army and navy air services.

Supercharging. The Calculated Performance of Airplanes Equipped with Supercharging Engines. E. C. Kemble. Nat. Advisory Committee for Aeronautics, report no. 101, 1921, 52 pp. 26 figs. Theoretical discussion of performance of aeroplane as affected by use of supercharging engine, together with comparative study of respective merits of different types of superchargers.

AEROPLANES

Caproni. Caproni's Latest Creation. Aeronautics, vol. 20, no. 388, Mar. 24, 1921, pp. 210, 2 figs. Flying boat with three triplane bodies. Specifications: Width, 33 meters; length, 24 meters; chord of wing, 275 meters; average speed, 140 km. per hr.; air endurance, 5–6 hr.

The Giant Caproni Tandem Triplane. Aerial Age, vol. 13, no. 5, April 11, 1921, pp. 103–104, 4 figs. Specifications: Power plant 8 Liberty 12-400 hp. engines; span, 100 ft.; length, 74 ft.; height, 31 ft. 6 in.; chord, 8 ft. 7 in.; empty, 30,000 lb.

Classification. Naming and Classifying Airplanes. Aviation, vol. 10, no. 13, Mar. 28, 1921, pp. 391. System adopted by Engineering Division of U. S. Army Air Service.

Design. The Extended Logarithmic Polar for the Calculation of Aeroplanes (Die erweiterte logarithmische Polare zur Flugzeugberechnung), Richard Vogt. Zeit. für Flugtechnik u. Motorluftschiffahrt, vol. 12, nos. 5, Mar. 15, 1921, pp. 69–73, 7 figs. It is shown that by means of a simple extension of the Eiffel logarithmic polars for determination of relations between carrying capacity, speed, plane-surface area and engine power, general graphic charts can be developed, and simple examples are given to illustrate their use.

The Factors That Determine the Minimum Speed of an Aeroplane, F. H. Norton. Aerial Age, vol. 13, no. 3, Mar. 28, 1921, pp. 57–60, 6 figs. It is computed that wing section affects minimum speed 26 per cent; aspect ratio, 4 per cent; gap chord ratio, 4 per cent; longitudinal control, 20 per cent; lateral control, 15 per cent; power in level flight, 5 per cent; vertical component of air screw thrust, 3 per cent; stagger, 2 per cent; scale, 2 per cent; and slip-stream on wings, 1 per cent.

German. German Aerial Developments. Erik Hildesheim. Aeronautics, vol. 20, no. 388, Mar. 24, 1921, pp. 198–200, 4 figs. Survey of types of aeroplanes under construction in German works.

Helicopters. See HELICOPTERS.

Military. Recent Progress in Military Aviation. H. S. Martin. Jl. Soc. Automotive Engrs., vol. 8, no. 4, April 1921, pp. 335–338, 7 figs. Military aeroplanes recently developed by U. S. Army Air Service.

Stability. Aeroplane Stability. Times Eng. Supp., no. 557, Mar. 1921, p. 102. Methods of longitudinal equilibrium.

[See also AVIATION, Soaring Flight.]

Wings. Some Experiments on Thick Wings with Flaps, C. D. Hanscom. Aerial Age, vol. 13, no. 4, April 4, 1921, pp. 79–82, 30 figs. Tests made in wind tunnel at Mass. Inst. Technology.

AIR LIFT

See PUMPS, Air-Lift.

AIRCRAFT

Design. Some Practical Points in the Structural Design of Aircrafts, A. P. Thurston. Engineering, vol. 121, no. 2881, Mar. 18, 1921, pp. 335–337, 8 figs. Also in Flight, vol. 13, no. 11, Mar. 17, 1921, pp. 194–197, 8 figs. Determination of maximum loads under various conditions of loading. Paper read before Instn. Aeronautical Engrs.

AIRCRAFT CONSTRUCTION MATERIALS

Fabrics. Airship Fabrics, J. W. W. Dyer. Aeronautics, vol. 20, nos. 387, 388 and 389, Mar. 17, 24 and 31, 1921, pp. 182–183, 200–202, and 225–226. Tensile properties and resistance to tearing. Bursting tests on larger models. Strength under sustained load. Methods of production. Fabrics for rigid airships.

AIR COMPRESSORS

Regulation, Automatic. Automatic Regulation of Compressors (Selbsttätige Regelung von Kompressoren), Robert Nitzschmann. Feuerungstechnik, vol. 9, no. 9, Feb. 1, 1921, pp. 74–75, 3 figs. Arrangement for remote control from compressed-air plant.

AIR FLOW

Meters. Notes on Small Flow Meters for Air, Especially Orifice Meters, Edgar Buckingham. U. S. Dept. of Commerce, Technologic Papers, Bur. of Standards, no. 184, Dec. 20, 1920, 15 pp., 1 fig. Note on selection, design and properties of small flow-meters for air.

AIRSHIPS

Rigid. The Technique of German Rigid Dirigibles (La technique des dirigeables rigides allemands), J. Tanzi. Aerophile, vol. 29, nos. 3 and 4, Feb. 1–15, 1921, pp. 50–54, 6 figs. Developments during war.

Zeppelin. The Hull of the Rigid Airships, E. H. Lewitt. Aeronautics, vol. 20, no. 390, April 7, 1921, pp. 234–236, 7 figs. Study of stresses in hull of airships of Zeppelin type.

[See also BALLOONS.]

ALCOHOL

Industrial. Raw materials for Industrial Alcohol Production. Chas. F. Juritz. So. African Jl. of Industries, vol. 4, no. 2, Feb. 1921, pp. 167–175. Yields from sugar-beet, prickly-pear fruit, molasses, potatoes, sweet potatoes, maize, acorns, prickly-pear leafstems, straw and sawdust.

Recovery from Coke-Oven Gas. Alcohol from Coke-Oven Gas, Cecil P. Tidman. Colliery Guardian, vol. 121, no. 3141, Mar. 11, 1921, p. 714. Also Iron & Coal Trades Rev., vol. 102, no. 2767, Mar. 11, 1921, p. 350. Experiments at Skinningrove Works, England. Paper read before joint meeting of Soc. Chem. Industry & Cleveland Instn. Engrs.

[See also AUTOMOBILE FUELS, Alcohol.]

ALLOY STEELS

Burrowlite. Imparts Odd Properties to Steel. Iron Trade Rev., vol. 68, no. 14, April 7, 1921, pp. 974–975, 1 fig. Alloy discovered by Dr. L. P. Burrowlite while experimenting with nickel ores. It is made from nickeliferous ore obtained in Sudbury district of Ontario. Alloy gives steel property of machinability even when showing qualities of extreme hardness.

ALLOYS

Ternary. Coefficients of Equivalence in Ternary Alloys, Léon Guillet and Albert Portevin. Chem. & Metallurgical Eng., vol. 24, no. 14, April 6, 1921, pp. 609–612, 4 figs. General discussion of effect of adding little of third element to binary alloy. Mathematical development of equations defining isomicrographic lines, and boundaries of zones showing two well-defined constituents. (Abstract.) Translated from Revue de Métallurgie.

AMMONIA

Synthesis. Some Interpretations of the Ammonia Synthesis Equilibrium, R. S. Tour. Jl. Indus. & Eng. Chem., vol. 13, no. 4, April 1921, pp. 298–300, 3 figs. Curves showing effect on equilibrium of ammonia content of variation of any one of conditions involved when others are held at arbitrary values.

AMMONIA COMPRESSORS

Apeldoorn. Apeldoorn Ammonia Compressors and the Apeldoorn Two-Pressure Evaporator System of Refrigeration. Practical Engr., vol. 63, no. 1777, Mar. 17, 1921, pp. 164–168, 7 figs. Double-acting horizontal compressors with multiple-opening disk valves in cylinder body.

Rod Packing. Ammonia Compressor-Rod Packing, W. H. Motz. Power, vol. 53, no. 14, April 5, 1921.

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NOTE.—The abbreviations used in indexing are as follows:

Academy (Acad.)	Engineer[s] (Engr[s])	Machinery (Machy.)	Record (Rec.)
American (Am.)	Engineering (Eng.)	Machinist (Mach.)	Refrigerating (Refrig.)
Associated (Assoc.)	Gazette (Gaz.)	Magazine (Mag.)	Review (Rev.)
Association (Assn.)	General (Gen.)	Marine (Mar.)	Railway (Ry.)
Bulletin (Bul.)	Geological (Geol.)	Materials (Matls.)	Scientific or Science (Sci.)
Bureau (Bur.)	Heating (Heat.)	Mechanical (Mech.)	Society (Soc.)
Canadian (Can.)	Industrial (Indus.)	Metallurgical (Met.)	State names (Ill., Minn., etc.)
Chemical or Chemistry (Chem.)	Institute (Inst.)	Mining (Min.)	Supplement (Supp.)
Electrical or Electric (Elec.)	Institution (Instn.)	Municipal (Mun.)	Transactions (Trans.)
Electrician (Elecn.)	International (Int.)	National (Nat.)	United States (U. S.)
	Journal (Jl.)	New England (N. E.)	Ventilating (Vent.)
	London (Lond.)	Proceedings (Proc.)	Western (Wgst.)

pp. 543-545, 4 figs. Comparative value of different types of packing.

APPRENTICES, TRAINING OF

Machine Industry. Training Men for the Machine Industry, Erik Oberg. Machy. (N.Y.), vol. 27, no. 8, April 1921, pp. 779-782, 6 figs. Organization of educational and training departments established by Norton Co., Worcester, Mass., with view to qualifying men for various classes of occupations in machine industry.

National Apprenticeship Council. Apprenticeship Plan Drawn Up by Joint Conference Board. Contract Rec., vol. 35, no. 14, April 6, 1921, pp. 336-339. Formation of National Apprenticeship Council governing local councils is suggested. Apprenticeship agreement enforces employers to provide time for education along technical lines.

ASHES

Weight of Conical Pile. The Weight of a Conical Pile of Ashes, N. G. Near. Power Plant Eng., vol. 25, no. 8, April 15, 1921, p. 418, 1 fig. Chart giving weight of conical pile of ashes.

AUTOMOBILE ENGINES

Assembling. Methods of Motor Assembly. Am. Mach., vol. 54, no. 15, April 14, 1921, pp. 641-645, 14 figs. Practice in assembling of Essex motor.

Gray-Beall. New Four-Cylinder Engine to be a Stock Product, J. Edward Schipper. Automotive Industries, vol. 44, no. 13, Mar. 31, 1921, pp. 694-695, 2 figs. Gray-Beall 3½ by 5 in. four-cylinder overhead-valve engine.

High-Speed. High-Speed Engines of Small Piston Displacement, Louis Chevrolet and C. W. Van Ranst. Jl. Soc. Automotive Engrgs., vol. 8, no. 4, April 1921, pp. 368-374, 8 figs. Racing engine designed by Frontenac Motor Co., Indianapolis.

Oldsmobile. To Produce New Eight-Cylinder Engine for Use in Oldsmobile Chassis, J. Edward Schipper. Automotive Industries, vol. 44, no. 12, Mar. 24, 1921, pp. 642-646, 7 figs. Engine will be produced in quantity, using new tool equipment especially designed for purpose. Cylinders will have rolled finish in place of ground surface. Blocks and heads to be interchangeable. Pressure lubrication and high speed, two-bearing crankshaft among features.

Starters. Instantaneous Current and Voltage Values in Battery, G. W. Vinal and C. L. Snyder. Jl. Soc. Automotive Engrs., vol. 8, no. 4, April 1921, pp. 319-327 and 364, 17 figs. Experiments conducted at Bur. of Standards to determine effects of temperature, compression, lubrication, distributor action and flywheel velocity upon operation on starter system.

Turmo. A New Four-Cylinder Engine of Conventional Design, J. Edward Schipper. Automotive Industries, vol. 44, no. 15, April 14, 1921, pp. 800-802, 5 figs. Turmo engine intended for passenger car or light truck applications. Four 3½ by 5 in. cylinders develop maximum of 47 hp. at 2200 r.p.m. Full pressure-feed lubrication and ample water-jacket space are provided.

AUTOMOBILE FUELS

Alcohol. Forest Products as Motor Fuels, E. C. Schertard. Sci. Lubrication, vol. 1, no. 2, Feb. 1921, pp. 8-13 and 25. Possibilities of ethyl alcohol as substitute for gasoline or as auxiliary for blending purposes.

Progress in Tests of Alcohol as Fuel. Power Wagon, no. 197, April 1921, p. 20. Report of British Empire Motor Fuels Committee.

The Carburetion of Alcohol, A. W. Scarratt. Jl. Soc. Automotive Engrs., vol. 8, no. 4, April 1921, pp. 328-330, 2 figs. Characteristic curves of four-cylinder engine equipped with special hot-spot manifold for burning alcohol.

Benzol. Benzol for Motor Fuel. Gas & Oil Power, vol. 16, no. 186, Mar. 3, 1921, p. 84. Specifications of British Eng. Standards Assn. Benzol is defined as mixture of benzene and not more than 30 per cent by volume of toluene and xylenes.

Kerosene. Utilization of Kerosene as Automobile Fuel (L'emploi des pétroles lampants dans les moteurs d'automobiles), A. Grebel. Genie Civil, vol. 78, no. 14, April 2, 1921, pp. 289-295. Technical study of carburetion of kerosene and account of experiments conducted at Schneider works in France.

Natalite. Data Concerning the Advantages, Production and Cost of "Natalite" Motor Fuel. Int. Sugar Jl., vol. 23, no. 267, Mar. 1921, pp. 147-153, 2 figs. Mixture consisting of 55 per cent alcohol, 44.9 per cent ether, and 0.1 per cent ammonia. (To be continued.)

Palm Oil. Palm Oil as Engine Fuel. Gas & Oil Power, vol. 16, no. 186, Mar. 3, 1921, pp. 85-86. Tests in Brussels with palm oil and other vegetable oils grown in Belgian Congo.

Research. Motor Fuel. So. African Eng., vol. 32, no. 3, Mar. 31, 1921, pp. 55-56. Research on utilization of gasoline substitutes as automobile fuels. Report of Empire Motor Fuels Committee of Imperial Motor Transport Council.

Semi-Water Gas. Utilization of Water Gas as Automobile Fuel (Utilisation du gaz pauvre a l'alimentation des moteurs d'automobiles), E. H. Lemonon. Nature (Paris), no. 2445, Feb. 12, 1921, pp. 105-112, 10 figs. Records of experiments. Apparatus used for operating Ford car by means of gas.

AUTOMOBILES

Carburetors. See CARBURETORS.

Clutch and Gear-Box Design. Developments in Transmission, S. Bramley-Moore. Jl. Soc. Automotive Engrs., vol. 8, no. 4, April 1921, pp. 359-364, 25 figs. Developments in clutch and gear box design which have been suggested with a view to reducing cost of upkeep.

Drive Gears. Gears for Motor Transmissions, Fred H. Colvin. Am. Mach., vol. 54, no. 14, April 7, 1921, pp. 606-609, 14 figs. Machining and assembling operations.

Research. Much Useful Automotive Research in Progress at Bureau of Standards, Herbert Chase. Automotive Industries, vol. 44, no. 14, April 7, 1921, pp. 750-755, 7 figs. Work now proceeding includes tests of brake linings made with view to standardizing apparatus for this purpose, efficiency and endurance tests of truck axles, study of flame propagation and detonation phenomena, and test of lubricants intended to determine definitely what physical characteristics render oil best suited for use in automotive engines.

Transmission Units. Methods Used by Transmission Specialists, Fred H. Colvin. Am. Mach., vol. 54, no. 13, Mar. 31, 1921, pp. 537-540, 12 figs. Frame-case and bell-case types of transmission. Machining operations on two types. Special tools, fixtures and methods for economical production.

AVIATION

Aerial Transportation. Aerial Transportation as a Business Proposition, Glenn L. Martin. Jl. Soc. Automotive Engrs., vol. 8, no. 4, April 1921, pp. 347-349. Reliability of air transportation. Survey of developments of commercial transportation.

Airplane Efficiency in Public Transportation, H. White-Smith. Aviation, vol. 10, no. 16, April 18, 1921, pp. 498-501, 3 figs. Records of European commercial services. Paper read at Efficiency Exhibition, London.

Canadian Air Progress—1920. Aviation, vol. 10, no. 12, Mar. 21, 1921, pp. 372-375.

Commercial Future of Aviation (L'avenir commercial de l'aviation), M. Maurice Duval. Ingenieur, vol. 36, no. 11, Mar. 12, 1921, pp. 199-203. Economical advantage of aerial transportation.

Cloudy Weather. Aerial Navigation in Cloudy Weather (La navigation aérienne par temps de brume), M. de Gramont de Guiche. Aerophile, vol. 29, nos. 3 and 4, Feb. 1-15, 1921, pp. 42-45, 3 figs. Technical study. Report submitted to French commission of aerial transportation.

Commercial. Commercial Aviation in Germany, W. Wronsky. Aviation, vol. 10, no. 13, Mar. 28, 1921, pp. 402-403, 1 fig. Possibilities of development. Translated from Der Luftweg.

The Next Steps in Commercial Aviation, Jesse L. Vincent. Flying, vol. 10, no. 3, April 1921, pp. 87-90, 3 figs. Visualizes probable future developments in design of aeroplanes for commercial purposes.

Customs Regulations. French Aircraft Customs Regulations. Aviation, vol. 10, no. 13, Mar. 28, 1921, pp. 392-393. Regulations and customs formalities to be applied to all aircraft entering or leaving France.

Flight Tests. Accelerations in Flight, F. H. Norton and E. T. Allen. Nat. Advisory Committee for Aeronautics, no. 99, 1921, 8 pp., 34 figs. Tests at Langley Field station conducted to obtain magnitude of load factors in flight and to procure information on behavior of airplane in various maneuvers.

Military. Angles of Attack and Air Speeds During Maneuvers, E. P. Warner and F. H. Norton. Nat. Advisory Committee for Aeronautics, no. 105, 1921, 12 pp. 9 figs. Experiments on direct measurement of angles of attack during maneuvers.

Soaring Flight. Dr. Nimführ's Solution of the Soaring Flight Problem, Alfred Gradenwitz. Aeronautics, vol. 20, no. 388, Mar. 24, 1921, pp. 203-204. Automatic stabilizer for aeroplanes.

Sailing Flight, R. DeVillamil. Aeronautics, vol. 20, no. 387, Mar. 17, 1921, pp. 180-181, 4 figs. Mechanics of soaring flight.

The Characteristics of Soaring Flight (Segelflugwesen), E. Rumpler. Zeit. für Flugtechnik u. Motorluftschiffahrt, vol. 12, no. 4, Feb. 28, 1921, pp. 50-53. Discusses expediency of different types of soaring airplanes, especially those figuring in the Rhön soaring-flight contest; and recommends that the study of soaring flight should replace that of gliding.

AVIATORS

Tests. Intelligence Tests at High Altitudes, Alfred Gradenwitz. Aeronautics, vol. 20, no. 389, Mar. 31, 1921, pp. 221-222, 3 figs. Results of intelligence tests in diluted air.

B

BALANCING

Machine Members. Loss of Energy through Unbalance in Rapidly Rotating Machine Parts (Energieverlust durch Unbalanz), Hans Heymann. Betrieb, vol. 3, no. 13, Mar. 25, 1921, pp. 363-366, 9 figs. Study of such sources of errors in the mass distribution of a rotating machine part as interfere with the smooth running of the body during operation of machine.

BALLOONS

Pilot. The Rate of Ascent of Pilot Balloons, B. J. Sherry. U. S. Dept. of Agriculture, Monthly Weather Rev., vol. 48, no. 12, Dec. 1920, pp. 692-694, 1 fig. Factors controlling rate of ascent of pilot balloons. Records of experiments.

Predetermination of Form. Predetermination of the Form of an Inflated Balloon (Prédetermination de la forme d'un ballon gonflé). Technique automobile et Aerienne, vol. 12, no. 112, 1921, pp. 11-14, 3 figs. Graphical study of forces acting within envelope of non-rigid dirigible balloon.

BEAMS

Buckling of. Flexural Buckling, Albert E. Guy. Army Ordnance, vol. 1, no. 5, March-April 1921, 256-261, 15 figs. Laws of buckling of cantilever beams on uniform rectangular sections.

Reinforced-Concrete. Effect of Repeated Reversals of Stress on Double-Reinforced Concrete Beams, W. A. Slater, G. A. Smith and H. P. Mueller. U. S. Dept. of Commerce, Technologic Papers, Bur. of Standards, no. 182, Dec. 20, 1921, 51 pp., 33 figs. For all of beams tested failure was by tension in steel. Generally beams in which highest stresses were developed in test withstood smaller number of repetitions of load than those in which measured stresses were smaller.

Torsion on Rectangular Cross-Sections, C. R. Young. Can. Engr., vol. 40, no. 12, Mar. 24, 1921, pp. 315-318, 2 figs. Formulas for determining stresses in beams of rectangular section. Method of reinforcing concrete beams for torsion.

BEARINGS, BALL

Lubrication. Requirements for Ball Bearing Lubrication, J. B. Castino. Sci. Lubrication, vol. 1, no. 2, Feb. 1921, pp. 18-19 and 31, 4 figs. Specifications for greases and oils.

BENZOL

Uses. Benzole—Its Recovery, Rectification, and Uses. Gas Jl., vol. 153, no. 3008, Jan. 5, 1921, pp. 31-33. Review of book by S. E. Whitehead published by Benn Bros., London.

[See also AUTOMOBILE FUELS, Benzol.]

BLAST-FURNACE GAS

Dust Recovery. Blast-Furnace Flue Dust Recovery, George B. Cramp. Iron Age, vol. 107, no. 12, Mar. 24, 1921, pp. 775-778, 1 fig. Automatic apparatus for wet recovery of flue dust.

Handling Flue Dust Economically, George B. Cramp. Iron Trade Rev., vol. 68, no. 12, Mar. 24, 1921, pp. 836-839, 1 fig. Plan for recovery of blast-furnace flue dust and charging it in form of sludge into top of stack.

BLASTING

Liquid-Oxygen. Blasting with Liquid Oxygen, S. P. Cortland. Sci. Am. Monthly, vol. 3, no. 4, April 1921, pp. 333-336, 6 figs. Equipment and procedure.

BOILER EXPLOSIONS

Abo, Finland. Steam-Boiler Explosion in the Abo Electrical Works (Finland) (Dampfkesselexplosion im Elektrizitätswerk Abo), M. Klein. Zeit. des Vereines deutscher Ingenieure, vol. 65, no. 11, Mar. 12, 1921, pp. 266-267, 3 figs. Account of explosion and results. Action of difference of temperature in the shell plates of upper boiler. Similarity of explosion to that in the central power plant Franken in Nuremburg, Germany.

BOILER FEEDWATER

Treatment. Economic Production of Distilled Water for Steam Central Stations (Production économique de l'eau distillée pour les centrales thermiques), M. J. Leleu. Chaleur & Industrie, vol. 2, no. 2, Feb. 1921, pp. 75-78, 4 figs. Triple-effect distiller operated by exhaust steam from pumps or turbine.

BOILER INSPECTION

National Board of Boiler Inspectors. Constitution and By-Laws of National Board of Boiler Inspectors. Boiler Maker, vol. 21, no. 4, April 1921, pp. 107-109. Object of association is to promote uniformity of construction and inspection of boilers in U. S.

Regulations. Regulations for Inspection of Railway Steam Boilers, other than Locomotive Boilers. Can. Ry. & Mar. World, no. 278, April 1921, p. 179. General order passed on Feb. 16, 1921, by Board of Ry. Commissioners for Canada.

BOILER OPERATION

Combustion. Heating Value in Connection with Steam-Boiler Investigations (Der Heizwert bei Dampfkesseluntersuchungen), H. Hilliger. Zeit. des Vereines deutscher Ingenieure, vol. 65, no. 11, Mar. 12, 1921, pp. 270-272, 4 figs. Notes on quantity of saturated vapor in combustion gases; importance of the separation of water from the combustion gases for operation and boiler efficiency; consideration of higher heating value in tests.

Instruments. Boiler Operation at the Power Plant of the Mesta Machine Company, C. Fischer. Blast Furnace & Steel Plant, vol. 9, no. 4, April 1921, pp. 239-247, 9 figs. Installation of mechanical devices and instruments.

BOILERS

Electrically Heated. Bergeon-Frédet Electric Boiler (Le générateur de vapeur "Bergeon-Frédet" à chauffage électrique), Houille Blanche, vol. 20, nos. 49 and 50, Jan.-Feb. 1921, pp. 24-25, 3 figs. Three-phase current of 50 periods is applied at pressure of 6500 volts.

Heat Transmission. Tests on Heat Transmission in Steam Boilers (Considération sur la transmission de la chaleur dans les générateurs de vapeur dé-

duites d'essais de vaporisation), Victor Kammerer. Bulletin de la Société Industrielle de Mulhouse, vol. 86, no. 8, Nov. 1920, pp. 519–582, 10 figs. Experiments on water-tube boiler. Empirical equations are constructed from results found.

Marine. See MARINE BOILERS.

Sectional. Sectional Boilers Composed of Sections Connected in Series and Surrounding the Feeding Chute and a New Device for Testing the Feeding Chute [Gliederkessel aus hintereinander geschalten den Füllschacht umschliessenden Gliedern und Füllschacht-Prüfungseinsatz (D.R.P.)]. Gesundheits-Ingenieur, vol. 44, no. 12, Mar. 19, 1921, pp. 134–135, 4 figs. Describes new patented device.

BOILERS, WATER-TUBE

Marine. Advantages of the Use of the Water-Tube Boiler in the Mercantile Marine, James Kemnal. Trans. North-East Coast Instn. Engrs. & Shipbuilders, vol. 37, part 4, Feb. 1921, pp. 185–192 and (discussion), pp. 193–208, 8 figs, partly on 3 supp. plates. Chief advantages claimed for water-tube boiler over cylindrical boiler are greater safety, possibility of using higher pressures and saving in weight.

BRAKES

Train, Automatic. Successful Test of the Automatic Straight Air Brake on the Norfolk & Western Railway. Ry. & Locomotive Eng., vol. 34, no. 4, April 1921, pp. 91–98, 12 figs.

Train, Tests. Handling 9,000 Tons Down a 1.6 per cent Grade. Ry. Rev., vol. 68, no. 14, April 2, 1921, pp. 515–521, 9 figs. Tests conducted by Norfolk & Western on control of 70-car train with automatic straight air brakes.

BRASS

Aluminum in. Influence of Small Quantities of Aluminum Upon the Properties of Brass, J. Czochralski. Brass World, vol. 17, no. 3, Mar. 1921, p. 64. Tests showed that aluminum content greater than about 0.06 per cent exerts injurious influence upon brass.

BROACHES

Burnishing. Burnishing Broaches, E. A. Dixie. Am. Mach., vol. 54, no. 14, April 7, 1921, pp. 599–601, 8 figs. How to make and use broaches. Kinds of spoiled work that may be reclaimed by their use. Turning broached work with diamond.

BROACHING

Keyways. Guide Bushings for Keyway Broaching, Carl H. Briggs. Machy. (N.Y.), vol. 27, no. 8, April 1921, pp. 767–769, 4 figs. Formulas for designing bushings for broaching accurate keyways.

BUILDING CONSTRUCTION

Electric Welding in. Electrically-Welded Structural Steelwork. Engineering, vol. 121, no. 2881, Mar. 18, 1921, pp. 323, 3 figs. Welding used for extension of foundry building.

BULKHEADS

Deflections. Notes on Deflections of Bulkheads and of Ships, A. M. Robb. Engineering, vol. 111, no. 2883, April 1, 1921, pp. 407–410, 21 figs. Application of theory of beams to investigation of bulkhead stiffening.

Spacing. On the Spacing of Transverse Bulkheads, K. G. Finlay. Engineering, vol. 111, no. 2883, April 1, 1921, pp. 403–405, 6 figs. Scheme for determining subdivisions of bulkheads.

BUSES

London. Motor Omnibus for the London General Omnibus Company, Limited. Engineering, vol. 111, no. 2883, April 1, 1921, pp. 391–392, 9 figs. partly on supp. plate. Double deck buses with total seating capacity of 54 passengers.

C

CALCULATING MACHINES

Manufacture. Calculating Machines. Times Eng. Supp., no. 557, Mar. 1921, p. 99. Principles involved in manufacture of machines for performing divisions and extracting square roots automatically.

CAMS

Design. Calculation of Inertia Forces in Mechanisms Operated by Cams (Calcul des efforts d'inertie dans les mécanismes commandés par des cames) P. Cayére. Arts et Métiers, vol. 74, no. 4, Jan. 1921, pp. 28–30, 6 figs. Construction of acceleration graphs for typical mechanisms.

Manufacture. Production of Accurate Cams, E. A. Dixie. Am. Mach., vol. 54, no. 13, Mar. 31, 1921, pp. 553–556, 15 figs. Fixtures employed in manufacture of typical cams.

CAR AXLES

Manufacture. The Manufacture of Railway Axles Ry. Engr., vol. 42, no. 494, Mar. 1921, pp. 85–87, 4 figs. Special machinery and equipment developed by British manufacturers.

CAR CONSTRUCTION

Support on Trucks. New Type of Support of a Railway Car on Trucks (Nouveau type de suspension pour voiture a bogies), M. Leboucher. Revue générale des Chemins de Fer, vol. 39, no. 12, Dec. 1920, pp. 271–294, 28 figs. Method developed by French Southern Ry. Springs possessing variable flexibility and having no friction between their elements. Records of service of cars fitted with system.

CAR COUPLINGS

Automatic. Automatic Couplings for Railway Rolling-Stock. Ry. Engr., vol. 42, no. 495, April 1921, pp. 135–136, 4 figs. Automatic coupling on railways and terminals systems in Switzerland.

The Boonzaier Automatic Coupling. Ry. Engr., vol. 42, no. 495, April 1921, p. 129, 3 figs.

CAR WHEELS

Chilled Iron. Manufacture, Properties and Uses of Chilled Iron Wheels (Les roues en fonte trempée, leur fabrication, propriétés et usages), M. E. Polushkin. Revue de Métallurgie, vol. 18, no. 1, Jan. 1921, pp. 143–57, 10 figs. Heat-treating process. Interpretation of photomicrographs. Bibliography. (Concluded.)

CARBOCOAL

See FUELS, Carbocoal.

CARBURETORS

Manifolds, Vaporizing in. Vaporising in the Manifold, Robert W. A. Brewer. Autocar, vol. 46, no. 1324, Mar. 5, 1921, pp. 429–431, 7 figs. Study of conditions of carburation and of correct methods of insuring vaporization of fuel.

CARS, FREIGHT

Container System. Container System Extended on the New York Central. Ry. Rev., vol. 68, no. 16, April 16, 1921, pp. 600–602, 4 figs. Container system was first operated for express car and is now being extended to freight service.

Draft-Gear Tests. Draft-Gear Tests of the Railroad Administration. Ry. Mech. Engr., vol. 95, no. 4, April 1921, pp. 229–232, 4 figs. Investigations conducted by inspection and test section of Baltimore & Ohio Railroad.

Gondola. New Norfolk & Western 100-Ton Coal Cars, John A. Pilcher. Ry. Age, vol. 70, no. 15, April 15, 1921, pp. 923–928, 9 figs. Body supported on side bearings instead of center plate. New type six-wheel truck.

CARS, PASSENGER

Steel. Safety of Passengers in Steel Cars, Frank M. Brinkerhoff. Official Proc. New York Railroad Club, vol. 31, no. 5, Mar. 18, 1921, pp. 6399–6413 and (discussion) pp. 6413–6433, 12 figs. Suggests protection of steel cars with special arrangement of cable loops at ends, to prevent telescoping in accidents.

The Safety of Passengers in Steel Railway Cars· Frank M. Brinckerhoff. Ry. Mech. Engr., vol. 95, no. 4, April 1921, pp. 223–227, 8 figs. Also in Ry. Age, vol. 70, no. 12, Mar. 25, 1921, pp. 781–785, 8 figs. Discussion of action of cars in accidents and methods which will avoid telescoping. Paper read before New York Railroad Club.

The Steel Passenger Cars of the Prussian-Hessian State Railroad (Die eisernen Personenwagen der preussisch-hessischen Staatsbahnen), H. Speer. Zeit. des Vereines deutscher Ingenieure, vol. 65, nos. 11 and 12, Mar. 12 and 19, 1921, pp. 261–265 and 295–297, 15 figs. Objections to steel cars with regard to rusting, loosening of parts, influence of heat and use of material are said not to be justified; the consumption of ore is offset by the saving effected in coal with the operation of the lighter-weight steel cars. Economy in construction and maintenance is set forth.

CAST IRON

Filtering. The Filtering of Cast Iron (Le filtrage de la fonte), D. Mathu. Fonderie Moderne, no. 1, Jan. 1921, pp. 9–16, 15 figs. Brunelli process for filtering cast iron by pouring it through special funnel which removes impurities.

Nickel, Influence on. Influence of Nickel on Cast Iron. Automotive Industries, vol. 44, no. 13, Mar. 31, 1921, pp. 705. Results of tests on cast iron with nickel and cobalt additions. Addition of one per cent nickel increased compressive and transverse strength 30 per cent while tensile strength increased 25 per cent and hardness 18 per cent. Effect of cobalt is reverse of that of nickel, except in respect to hardness.

CASTINGS

Centrifugal. Centrifugal Castings. Engineering, vol. 121, no. 2881, Mar. 18, 1921, pp. 311–312, 6 figs. Methods and machines employed for casting cylindrical articles under centrifugal pressure at works of Stokes Castings, Ltd., Mansfield, England.

Cleaning. Cleaning and Dressing Castings, F. W. Wilson. Foundry Trade Jl., vol. 23, no. 239, Mar. 17, 1921, pp. 243–246, 4 figs. Cleaning chamber for intricate castings. Paper read before Manchester Assn. Engrs.

Cleaning and Dressing Castings—II, F. W. Wilson, Machy. (Lond.), vol. 18, no. 443, Mar. 24, 1921, pp. 775–777, 4 figs. Details of sand-blasting apparatus.

CEMENT

Analysis. Chemical Analyses of Cement as Indicators of Behavior. Eng. News-Rec., vol. 86, no. 15, April 14, 1921, pp. 637–639, 2 figs. Rearrangement of stock analyses recommended so as to show true content of active agents.

Slabs. New Design Data for Cement Slabs. Am. Architect, vol. 119, no. 2359, Mar. 9, 1921, pp. 287–291, 10 figs. Tests at Lehigh University on slabs poured with mixture under pressure from nozzle.

CEMENT GUN

Uses. The Application of Cement Mixtures by Machinery, George J. Young. Eng. & Min. Jl., vol. 111, no. 13, Mar. 26, 1921, pp. 537–543, 6 figs. Summary of properties and examples of use of gunite in mining and metallurgical industry. Fireproofing of underground timber and surface structures. Prevention of slabbing by sealing rock surfaces and obviating action by air and moisture.

CEMENT, PORTLAND

Cal, Effect of. Effect of Cal in Portland Cement. Public Works, vol. 50, no. 14, April 2, 1921, pp. 278–279. Result of investigation by Bur. of Standards indicates acceleration of setting without reduction of ultimate strength.

Testing. Japanese Standard Rules for Testing Portland Cement. Eng. World, vol. 18, no. 4, April 1921, pp. 273–274. Issued by Dept. of Agriculture and Commerce on Feb. 10, 1905, revised Dec. 10, 1909, and June 20, 1919. Translated by Japan Portland Cement Assn.

Portland Cement, R. E. Stradling. Concrete & Constructional Eng., vol. 16, no. 3, Mar. 1921, pp. 169–177, 13 figs. Comparative study of British and foreign standards and methods of testing portland cement. (To be concluded.)

CENTRAL STATIONS

Electric-Furnace Operation. Electric Furnaces and Central Station Charges, H. O. Swoboda. Forging & Heat Treating, vol. 7, no. 3, Mar. 1921, pp. 190–193, 3 figs. Curves illustrating decrease of cost of electric energy with increasing load factor for various maximum demands. Comparison of electric-station load in industrial districts with and without electric furnace.

Mine-Mouth. A Mine-Mouth Super-Power Station. Power, vol. 53, no. 14, April 5, 1921, pp. 532–542, 22 figs. Total capacity is to be 300,000 kw., in units of 60,000 kw. Power is generated at 12,000 volts and is stepped up to 66,000 volts through bank of three 23,600-kva. transformers in power house. Station is located near coal mine about 50 miles from Pittsburgh.

Colfax Power Station of the Duquesne Light Company, Pittsburgh, D. L. Galusha and C. W. F. Clarke. Jl. Am. Inst. Elec. Engrs., vol. 40, no. 4, April 1921, pp. 281–294, 44 figs. Installation of two 60,000-kw. units first step in proposed 300,000 kw. power station for Pittsburgh district.

Reliability and Simplicity—Characteristics of New Colfax Station. Elec. World, vol. 77, no. 16, April 16, 1921, pp. 865–872, 19 figs. Generating station of Duquesne Light Co., designed for ultimate rating of 300,000 kw. Groups of six moderately rated stations under one roof operating in parallel on duplicate high-tension buses.

Colfax—A Superpower Plant at the Mouth of a Coal Mine. Elec. World, vol. 77, no. 14, April 2, 1921, pp. 753–760, 14 figs.

CHAINS

Anchor. New Method for Manufacture of Anchor Chain, Hubert Hermanns. Forging & Heat Treating, vol. 7, no. 3, Mar. 1921, pp. 156–158, 3 figs. German method of rolling chain from flat strip of wrought iron. Scarf weld is eliminated, making stronger and more uniform anchor chain.

CHARCOAL

Manufacture. The Production of Artificially Dense Charcoal, L. F. Hawley. Jl. Indus. & Eng. Chem., vol. 13, no. 4, April 1921, pp. 301–302, 1 fig. Report for distillation of briquets under mechanical pressure.

CHIMNEYS

Height. A New Method for Proportioning Chimney Heights, Robert Sibley and C. H. Delany. Jl. Electricity & Western Industry, vol. 46, no. 6, Mar. 15, 1921, pp. 299–300, 1 fig. Diagram showing available draft at chimney base for various rates of gas flow and chimney diameters. Rule for determining altitude.

CHROMIUM STEEL

Chromium-Tungsten. Recent Work on Chromium Tungsten Steel—Method of Magnetic Analysis Chem. & Metallurgical Eng., vol. 24, no. 13, Mar. 30, 1921, pp. 573–575, 3 figs. Review of literature of chromium-tungsten steels specially work Japanese investigators. First of series of articles.

Microstructure. Microstructure of Chromium Steels Chem. & Metallurgical Eng., vol. 24, no. 16, April 20, 1921, pp. 703–706, 16 figs. Brief review of literature, especially from Japanese investigator Murakami, presenting structural diagram, photomicrographs and explanation of changes in transformation temperature following various reheatings.

CHUCKS

Drill. Application of Interchangeability to Drill Chuck Manufacture. Machy. (Lond.), vol. 17, no. 441, Mar. 10, 1921, pp. 693–699, 9 figs. Tooling and gaging equipment in manufacturing Casler twinscrew drill chuck.

Magnetic. Magnetic Chucks—V, Ellsworth Sheldon. Am. Mach., vol. 54, nos. 14 and 15, April 7 and 14, 1921, pp. 602–605, 9 figs., and 650–652, 7 figs. Chucks manufactured by Blanchard Machine Co.

COAL

Carbonization. The Assay of Coal for Carbonisation Purposes, Thomas Gray and James G. King. Colliery Guardian, vol. 121, no. 3141, Mar. 11, 1921, pp. 716–717, 2 figs. Laboratory method. Technical paper of British Fuel Research Board.

Coking Capacity. The Better Utilization of Coking Slack, A. E. Beet and A. E. Findley. Trans. Instn. Min. Engrs., vol. 60, part 3, Feb. 1921, pp. 213–221, 2 figs. Means of preventing types of coal from going to coking plant which cannot be rendered by washing low enough in sulphur and ash to give coke suitable for metallurgical purposes. Method of utilizing these coals to best advantage.

Research. Fuel Research Bureau Advocated to Solve Problems of Scientific Use and Handling of Coal, F. R. Wadleigh. Coal Age, vol. 19, no. 13, Mar. 31, 1921, pp. 581–583. Lancashire and Cheshire (England) coal research association, suggested as model, resembles U. S. war research board, but is broader in scope. Has coal-testing plant and laboratory and also makes commercial investigations. Plan for American commission outlined.

Spontaneous Combustion. Causes of Spontaneous Combustion in Coal and Method of Treatment of Underground Fires, K. Neville Moss. Iron & Coal Trades Rev., vol. 102, no. 2769, Mar. 25, 1921, pp. 425–426, 3 figs. Effect of presence of iron pyrites in connection with underground fires.

COAL DUST

Combating Dangers of. Mine-Dusts: Sampling, Testing and Treatment, W. H. McMillan. Iron & Coal Trades Rev., vol. 102, no. 2767, Mar. 11, 1921, pp. 345–346. Methods of combating dangers arising from accumulations of coal dust, with reference to regulations recently enacted by British Government. Paper read before South Midland Branch, Nat. Assn. Colliery Managers.

COAL HANDLING

Belt Conveyor. Belt Conveyor Transfers Coal Across River with Suspension Bridge as Support, R. W. Shumway. Coal Age, vol. 19, no. 12, Mar. 24, 1921, pp. 525–527, 2 figs. With mine on one side of river and railroad on other it was necessary to move coal across stream without interfering with navigation. This was accomplished by means of suspension bridge carrying belt conveyor.

COAL WASHING

Froth Flotation. Froth Flotation as Applied to the Washing of Industrial Coal, Ernest Bury, Walter Broadbridge and Alfred Hutchinson. Trans. Instn. Min. Engrs., vol. 60, part 3, Feb. 1921, pp. 243–254, 4 figs. Principles of froth flotation and account of operation of froth-flotation process. Representative results obtained on various types of material. Economical aspects of process specially as applied to preparation of coal for production of metallurgical coke.

COKE

Testing. Standardizes the Testing of Coke. Iron Trade Rev., vol. 68, no. 15, April 14, 1921, pp. 1037–1038, 2 figs. Committee report of Southern Ohio Pig Iron Assn.

COMBUSTION

Surface. The Development of Surface Combustion. Zur Entwicklung der Oberflächenverbrennung), Otto Essich. Stahl u. Eisen, vol. 41, no. 7, Feb. 17, 1921, pp. 228–232, 16 figs. Gives experiences with small furnaces which, it is claimed, taking into consideration change of conditions, can also be applied to large furnaces.

COMPRESSED AIR

Metering. The Metering of Compressed Air, John L. Hodgson. Trans. Instn. Min. Engrs., vol. 60, part 3, Feb. 1921, pp. 271–280 and (discussion) pp. 280–287, 17 figs. Construction and operation of various types of meters.

CONCRETE

Blast-Furnace Slag. Tests with Blast-Furnace Slag (Versuche mit Hochofenschlacke), H. Burchartz. Stahl u. Eisen, vol. 41, no. 6, Feb. 10, 1921, pp. 193–200, 2 figs. Concrete from blast-furnace slag of the kind tested is said to harden just as well in salt water and is just as durable as gravel concrete. Results of tests show that blast-furnace slag is just as suitable for the production of concrete as natural gravel; and also that the resistivity of cement concrete in salt water is dependent primarily on the density of the concrete material.

Expansion and Contraction. Expansion and Contraction in Concrete Structures, Albert M. Wolf. Eng. World, vol. 18, no. 4, April 1921, pp. 233–236, 1 fig. Experimental results found by various investigators. Derivation of empirical formula for determining net contraction of concrete.

Proportioning. Proportioning Concrete on Job by Exact Methods, R. B. Young and T. V. McCarthy. Eng. News-Rec., vol. 86, no. 11, Mar. 17, 1921, pp. 456–458, 2 figs. Method developed by Hydro-electric Power Commission of Ontario.

Scientific Concrete (Hormigon cientifico), Roderick B. Young. Ingenieria Internacional, vol. 5, no. 5, May 1921, pp. 272–275, 4 figs. Method for proportioning aggregates of concrete based on surface of gravel units and experiments conducted to determine best proportions.

The New Methods of Proportioning Concrete in Theory and Practice, Roderick B. Young. Jl. Boston Soc. Civil Engrs., vol. 8, no. 3, Mar. 1921, pp. 73–108, 13 figs. Investigations of hydroelectric power commission of Ontario.

CONCRETE BLOCKS

Casting. The Calculation of Concrete Blocks (Note sur le calcul des pièces en béton de ciment fondu), A. V. Magny. Revue de l'Ingénieur, vol. 28, no. 3, Mar. 1921, pp. 125–136, 3 figs. Tests on blocks. Formulas for designing.

Tests. Quality Concrete Products. Concrete Products, vol. 20, no. 3, Mar. 1921, pp. 45–46 and 51–52. Results of tests on concrete block, brick and hollow concrete building tile. Specifications adopted by Am. Concrete Inst. for concrete block, brick, tile and architectural trim stone.

CONCRETE MIXERS

Sprenger Type. New Process of Making Concrete (Un nouveau procédé de fabrication du béton), E. Weiss. Nature (Paris), no. 2444, Feb. 5, 1921, pp. 95–96, 4 figs. Mixing apparatus invented by M. Sprenger. Wet sand and gravel are blown through atmosphere saturated with cement.

CONCRETE CONSTRUCTION, REINFORCED

Steel Forms. Steel Forms for Concrete Columns and Floor Slabs. Am. Architect, vol. 119, no. 2360, Mar. 16, 1921, pp. 332–334, 6 figs. Description of metal forms used in construction of Columbia Graphophone Co.'s new seven-story structure in Baltimore.

CONCRETE, REINFORCED

Reinforcing Steel. Tests on High Tension Steels in Reinforced Concrete Design, H. Kempton Dyson. Concrete & Constructional Eng., vol. 16, no. 3, Mar. 1921, pp. 161–168, 1 fig. Report of special committee on high tension steel in reinforced concrete of British Concrete Inst.

CONDENSERS, STEAM

Surface. Installations for the Prevention of Scale Formation in Surface Condensers (Anlagen zur Verhütung von Wassersteinbildung in Oberflächen-Kondensationen), Hans Rissmann. Zeit. des Oberschlesischen Berg- u. Hüttenmännischen Vereins, vol. 59, no. 6, 1920, pp. 185–205, 33 figs. Discusses means employed heretofore in prevention of scale formation from the cooling water; describes the Balcke inoculation process as a protection against incrustation and silting up with mud and demonstrates its economic value.

COPPER

Tests. Experiments on Copper Crusher Cylinder, Alexander I. Krynitsky. Dept. of Commerce Technologic Papers, Bur. of Standards, no. 185, Feb. 1, 1921, 32 pp. 15 figs. Compression tests on standard Riehlé testing machine. Length of cylinders decreased considerably under repeated application of load.

COPPER ALLOYS

Copper-Nickel. Copper-Nickel Alloys, Paul D. Merica. Chem. & Metallurgical Eng., vol. 24, no. 13, Mar. 30, 1921, pp. 558–560, 4 figs. Notes on structure and properties of alloys used for driving bands, condenser tubes and coinage. Various names and analyses for nickel silver are tabulated, with notes upon their most common uses.

Copper-Tin. The Constitution of the Alloys of Copper with Tin, III, John L. Haughton. Metal Industry, (Lond.) vol. 18, no. 13, April 1, 1921, pp. 241–247, 7 figs. Transformations other than formation of eutectic, occurring below 250 deg. cent. Range of composition studied was from about 40 per cent tin to 100 per cent tin.

Heat Treatment. Heat Treatment of Copper Alloys, J. S. Glen Primrose. Foundry Trade Jl., vol. 23, no. 241, Mar. 31, 1921, pp. 291–296, 10 figs. Experimental study of effect of heat-treatment upon tensile properties of copper-aluminum and copper-zinc alloys. Paper read before Instn. British Foundrymen.

Properties. Plastic Deformation of Some Copper Alloys at Elevated Temperatures, C. A. Edwards and A. M. Herbert. Engineering, vol. 121, no. 2881, Mar. 18, 1921, pp. 341–344, 11 figs. Also in Metal Industry (Lond.), vol. 18, no. 12, Mar. 25, 1921, pp. 221–229, 11 figs. Apparatus designed by writers for making indentation tests under dynamic stresses. Results of experiments with copper-zinc and copper-aluminum alloys. Paper read before Inst. of Metals.

CORROSION

Boiler Tubes. Unusual Boiler Tube Corrosion by Carbon Dioxide, Barzillai G. Worth. Am. Electrochemical Soc., Thirty-Ninth Gen. Meeting, April 21–23, 1921, no. 28, pp. 329–335, 2 figs. Corrosion was located as due to soluble iron bicarbonate in water used, which gave off large quantities of carbonic acid gas when heated in boiler.

Heating Systems. Practical Means of Preventing Corrosion of Iron and Steel Were Not Exposed Directly to the Atmosphere, F. N. Speller. Thirty-Ninth Gen. Meeting, Am. Electrochemical Soc., April 21–23, 1921, advance paper no. 5, pp. 37–46, 2 figs. Method sof deoxidizing water to prevent corrosion in hot-water heating systems.

Iron and Steel. Experiments on the Corrosion of Iron and Steel, T. S. Fuller. Am. Electrochemical Soc., Thirty-Ninth Gen. Meeting, April 21–23, 1921, no. 29, pp. 337–346, 16 figs. Observations of behavior of drops of water standing on pure iron and other metals, also standing partly on iron and partly on zinc or brass. Oxidation is usually perceptible in one minute and quite marked in 15 min.

Some Observations on the Mechanism of the Increased Corrosion Resistance of Steel and Iron Due to Small Copper Contents, D. M. Buck. Thirty-Ninth Gen. Meeting, Am. Electrochemical Soc., April 21–23, 1921, advance paper no. 6, pp. 47–53, 3 figs. Results of experiments.

The Corrosion of Old Iron, E. A. Richardson and L. T. Richardson. Thirty-Ninth Gen. Meeting, Am. Electrochemical Soc., April 21–23, 1921, advance paper no. 7, pp. 55–58. Analyses of specimens of iron and steel which had been subjected to atmospheric corrosion for 35 yr. Those containing over 0.10 per cent copper were in good condition, while of those containing less than 0.10 per cent copper some were in fair condition and others in poor condition.

Iron and Steel Pipe. Control of Corrosion in Iron and Steel Pipes, F. N. Speller. Jl. Eng. Inst. Canada, vol. 4, no. 4, April 1921, pp. 233–237, 2 figs. Causes of corrosion, external and internal, in iron and steel pipe mains with summary of control methods.

Non-Ferrous. Some Types of Non-Ferrous Corrosion, H. S. Rawdon. Thirty-Ninth Gen. Meeting, Am. Electrochemical Soc., April 21–23, 1921, advance paper no. 9, pp. 73–79, 8 figs. Examples of each of four types of corrosion: Selective attack of certain constituents; intercrystalline brittleness; internal oxidation; and simultaneous action of stress and corrosion.

Prevention. Principles of Alloying to Resist Corrosion, Oliver P. Watts. Thirty-Ninth Gen. Meeting, Am. Electrochemical Soc., April 21–23, 1921, advance paper no. 10, pp. 81–84, 1 fig. General principle is laid down that less corrodible alloys are either metallic compounds of simple chemical formula or solid solutions of more resisting metals in each other. Test proving protective action of copper in steel is given.

Theories. A Practical Aspect of the Corrosion Problem, John F. Thompson. Am. Electrochemical Soc., Thirty-Ninth Gen. Meeting, April 21–23, 1921, no. 30, pp. 347–354. Comparative study of various corrosion theories.

CRANES

Gantry. Special Storage Gantry. Iron Age, vol. 107, no. 16, April 21, 1921, p. 1041, 1 fig. Gantry crane of special design installed at storage yard of Peerless Motor Car Co., Cleveland.

Hammerhead. A Hammerhead Crane for the Harbor of Christiana, Norway (En Stor Kran). Teknisk Ukeblad, vol. 68, no. 2, Jan. 14, 1921, pp. 20–22, 2 figs. Cranes lifts 100 tons to a height of 25 m. and is intended mainly for installation and removal of boilers and ship engines. Its largest radius is 28 m.; motors, operated by alternating current at 220 volts, have a total capacity of 238 hp.

Traveling. Electromagnetic Traveling Crane of Five Tons Capacity and Twenty-Five Meters Radius (Pont-roulant électrique special de 5 tonnes et 25 mètres de portée), W. Druey. Bulletin technique de la Suisse romande, vol. 47, no. 6, Mar. 19, 1921, pp. 66–69, 4 figs. Installed at Oerkilon works for transporting structural steel.

CUTTING TOOLS

Standards. Report of the German Industry Committee on Standards (Mitteilungen des Normenausschusses der Deutschen Industrie). Betrieb, (special no.) vol. 3, no. 11, Mar., 1921, pp. 147–152, 7 figs. Proposed new standards for hand wheels, grain-milling rolls, and cutting tools.

CYLINDERS

Block Production. Utilization of Special Machines in Cylinder Block Production, J. Edward Schipper. Automotive Industries, vol. 44, no. 14, April 7, 1921, pp. 756–759, 22 figs. Manufacture of Paige cylinder blocks.

D

DIE CASTING

Developments. Die-Casting Methods and Metals—I, M. H. Potter. Foundry, vol. 49, no. 8, April 15, 1921, pp. 303–306. Advantages and limitations of die casting are discussed and development and present-day practice are outlined.

DIES

Bending. The Design and Construction of Press Tools. Eng. Production, vol. 2, nos. 24 and 26, Mar. 17 and 31, 1921, pp. 346–348, 8 figs., and 404–405, 6 figs. Design of bending and curling dies.

Shells. Dies for Producing a Conical Part, N. T. Thurston. Machy. (N. Y.), vol. 27, no. 8, April 1921, pp. 772–775, 14 figs. Operations in manufacturing system.

DIESEL ENGINES

Marine. Adjustment of Crosshead Pin Bearings and Main Bearings of Marine Diesel Engines, Louis R. Ford. Power, vol. 53, no. 14, April 5, 1921, pp. 546–547, 3 figs. Details of procedure.

Building Diesel Marine Engines for Seagoing Vessels—II, Fred B. Jacobs. Mar. Rev., vol. 51, no. 5, May 1921, pp. 221–229, 23 figs. Practice at works of Busch-Sulzer Bros., St. Louis, Mo.

The Polar Marine Diesel Engines. Practical Engr., vol. 63, no. 1775, Mar. 3, 1921, pp. 134–137, 4 figs. Four-cylinder type developing 500 b.hp. at 150 r.p.m.

Nordberg. Largest Stationary Diesel Engine in the United States. Power, vol. 53, no. 13, Mar. 29, 1921, pp. 498–501, 7 figs. Nordberg 2000 b.hp. vertical Diesel engine of valve-in-head scavenging two-stroke-cycle, single-acting type. Four power cylinders, 500 b.hp. each, scavenging pump and air compressor driven by crankshaft. Engines to be direct-connected to 1350-kw. a. c. generators to supply electrical service to copper mines.

Oil-Fuel Injection. Some Experiments in Connection with the Injection and Combustion of Fuel Oil in Diesel Engines. C. J. Hawkes. Trans. North-East Coast Instn. Engrs. & Shipbuilders, vol. 37, part 2, Dec. 1920, pp. 37–92, 28 figs. Experiments carried out at British Admiralty Engineering Laboratory in connection with development of high-speed engines for naval purposes.

Standardization. Standardized Diesel Engines—II. H. R. Setz. Mar. Eng., vol. 26, no. 4, April 1921, pp. 324–328, 8 figs. Discussion of construction involving four valves in cylinder head. Study of propelling characteristics.

Werkspoor. The "Werkspoor" Diesel Engines (Inleiding tot het bezichti gen vande Diesel-motoren voor de Billiton-Maatschappij) and (Inleiding tot een bezoek aan de Dieselmotoren-afdeeling van "Werkspoor"), G. J. Lugt. Ingenieur, vol. 36, no. 5, Jan. 1921, pp. 82–87 and 87–94, 25 figs. Describes two large stationary engines, constructed for the Billiton Co., with six cylinders of 5600 by 1000 mm. and 600 r.p.m. which are directly coupled with 3-phase generators; the cylinders are arranged on a distance piece which is tied to base plate; pressure lubrication, combined crankshafts, 3-stage compressors, and cooling of pistons through telescopic tubes. In second paper author discusses certain constructions intended for marine engines only.

DRILL CHUCKS

Manufacture. Application of Interchangeability to Drill Chuck Manufacture—II. Machy. (Lond.), vol. 17, no. 442, Mar. 17, 1921, pp. 725–730, 18 figs. Tooling and gaging equipment employed in manufacturing Casler twin-screw drill chuck.

DRILLING MACHINES

Automatic. Special Automatic Drilling Machines. Iron Age, vol. 107, no. 15, April 14, 1921, p. 975, 1 fig. Machine designed to drill six holes within slotted space 1 in. long on door-lock cylinder. Manufactured by Langelier Mfg. Co., Providence, R. I.

Inverted-Spindle. Defiance Inverted-Spindle Drilling Machine. J. V. Hunter. Am. Mach., vol. 54, no. 15, April 14, 1921, pp. 633–634, 2 figs. Machine constructed by Defiance Machine Works, Defiance, Ohio.

Radial. The Advantage of Rigid Construction in Radial Drilling Machines (Der Vorteil der stabilen Durchbildung von Radial-Bohrmaschinen), Fritz Hensel. Betrieb (special no.), vol. 3, no. 11, Mar. 1921, pp. 302–305, 6 figs. Demonstrates approved construction and economical drive of modern radial drilling machines, and presents curves showing difference in the performance of modern rigid types as compared with older forms of machines.

DRILLS

Standard. Report of the German Industry Committee on Standards (Mitteilungen des Normenausschusses der Deutschen Industrie). Betrieb, vol. 3, no. 13, Mar. 25, 1921, pp. 171–180, 11 figs. Proposals of the Board of Directors for tool tapers, Morse tapers, conical reamers for Morse and metric tapers, and metric tapers. As a basis for the standardization of the Morse tapers the original table of the Morse Twist Drill & Machine Co., New Bedford, Mass., is used.

Twist. The Utilization of Broken Twist Drills (Die Wiederverwendung von gebrochenen Spiralbohrern), H. Kummer. Betrieb, vol. 3, no. 10, Feb. 25, 1921, pp. 267–269, 1 fig. Patented device by means of which it is possible to make use of broken twist drills.

Wood Bits and Center Drills. Wood Bits and Adjustable Center Drills (1. Holzbohrer. 2. Verstellbare Zentrumbohrer), Otto Wenzel. Betrieb, vol. 3, no. 10, Feb. 25, 1921, pp. 272–278, 45 figs. Wood bits: Classification of bits according to drilling work; comparison of different kinds with regard to shape and use in auxiliary tools and machines. Adjustable-center drills: Investigation of the different types with regard to cutting angle, adjustability, renewal of separate parts, formation of cutting and strength.

DROP FORGINGS

Malleable Iron versus. Why Drop Forgings Are Replacing Malleable Iron Castings. F. B. Fairbanks. Forging & Heat Treating, vol. 7, no. 3, Mar. 1921, pp. 173–175, 8 figs. Comparative study of photomicrographs.

E

EDUCATION, ENGINEERING

Industrial Production. The Scarcity of the College-Trained Engineer in Production, John Airey. Eng. Education, vol. 11, no. 6, Feb. 1921, pp. 290–297. Suggests college engineering institution spend transitory period as foremen in factory instead of in office or laboratory. This, it is believed, would fit them better to direct production in industry properly.

ELECTRIC DRIVE

Steel Mills. The Frequency Problem in the Steel Industry. B. G. Lamme. Jl. Am. Inst. Elec. Engrs., vol. 40, no. 4, April 1921, pp. 294–300. Possibilities for utilization of 50 cycles. Comparative advantages and disadvantages of 25 and 60 cycles.

ELECTRIC FURNACES

Electrodynamic Forces in. Electrodynamic Forces in Electric Furnaces, Carl Hering. Thirty-Ninth Gen. Meeting, Am. Electrochemical Soc., April 21–23, 1921, advance paper no. 19, pp. 201–211, 4 figs. Utilization of electrodynamic forces to cause liquid metal to flow rapidly through heat-developing resistor, thereby enabling furnace to be forced and to cause strong upward circulation in adjoining bath, by which metal is refined of suspended impurities and made homogeneous.

Heroult. Electric-Furnace Practice at Treadwell, W. E. Cahill. Min. & Sci. Press, vol. 122, no. 16, April 16, 1921, pp. 535–537, 2 figs. Heroult electric furnace used by Alaska Treadwell Gold Mining Co.

Inductive. Recent Progress in High Frequency Inductive Heating, E. F. Northrup. Am. Electrochemical Soc., Thirty-Ninth Gen. Meeting, April 21–23, 1921, paper no. 18, pp. 179–200, 13 figs. Furnaces of certain types are described and actual performances given, showing them to run at 30 to 40 per cent electrothermal efficiency.

Muffled Arc. Develops New Non-Ferrous Melting Furnace. Iron Trade Rev., vol. 68, no. 16, April 21, 1921, pp. 1115, 2 figs. Muffled-arc type manufactured in two sizes by Gen. Elec. Co.

Muffled Arc Electric Furnace for Non-Ferrous Metals. Iron Age, vol. 107, no. 15, April 14, 1921, pp. 985–986, 4 figs. Type manufactured by Gen. Elec. Co. in two sizes, a 1500-lb. unit and a 50-lb. unit.

New Types of Electric Furnaces. Metal Industry, (N. Y.) vol. 19, no. 4, April 1921, pp. 149–150, 4 figs. Muffled arc furnaces developed by Gen. Elec. Co. for melting non-ferrous metal.

Non-Ferrous Alloys. Electric Furnaces for Non-Ferrous Alloys, H. W. Gillett. Am. Electrochemical Soc., Thirty-Ninth Gen. Meeting, April 21–23, 1921, no. 24, pp. 277–295. Tabulates in detail all electric furnaces in U. S. melting non-ferrous metals giving kind of furnace, users, and capacity per heat. There are 323 electric furnaces in 144 different plants with capacity of 193 tons per single heat and using 42,350 kw.

Non-Ferrous Industry. Electric Melting in Non-Ferrous Industry, Edwin F. Cone. Iron Age, vol. 107, no. 12, Mar. 24, 1921, pp. 770–772. Present status in U. S. Marked increase in last year. Furnaces sold total 408.

New Electric Furnace for Non-Ferrous Industry. Iron Age, vol. 107, no. 12, Mar. 24, 1921, pp. 772–773, 4 figs. Patented H. & H. reverberatory furnace. Heat is changed by means of arcs drawn between vertical electrodes and conducting horizontal bed within furnace.

Open-Hearth Versus. Makes Comparison of Melting Costs. Foundry, vol. 49, no. 8, April 15, 1921, pp. 315–318, 3 figs. Ohio Steel Castings Co. operating both electric and open-hearth furnace gives data covering two processes from which estimated costs are calculated.

Steel Manufacture. Electric Furnaces for Making Steel—II, Alfred Stansfield. Blast Furnace & Steel Plant, vol. 9, no. 4, April 1921, pp. 263–266, 5 figs. Classification of electric steel-making furnaces. General features and advantages of arc furnace and resistance furnace. Operating features of electric furnaces.

Electric Furnaces in Steel Manufacture (Le chauffage dans les fours électriques d'aciérie), M. M. Gillot and M. V. Guillermin. Revue de l'Industrie minréale, no. 5, Mar. 1, 1921, pp. 249–257, 10 figs. Types used.

The Regulation of Electric Steel Arc Furnaces Using Movable Electrodes, W. G. Mylius. Thirty-Ninth Gen. Meeting, Am. Electrochemical Soc., April 21–23, 1921, advance paper no. 20, pp. 213–225, 8 figs. Discussion of difficulties of operating arc furnaces for melting steel, particularly when melting cold scrap, and of kinds of arc current regulators which have been devised to maintain some function of power imput constant, such as current, voltage, watts, or a combination of these.

ELECTRIC LOCOMOTIVES

Swiss. Swiss Electric Locomotive Progress. Elec. Ry. Jl., vol. 57, no. 16, April 16, 1921, pp. 724–727, 9 figs. Details are given of recent locomotives manufactured by leading two builders of electrical apparatus in Switzerland. Particular attention is given to machines for federal railways. Some experiments with new types of drive are included, indicating leaning toward gears as substitute for side rods.

ELECTRIC WELDING, ARC

Rate of Cutting. Solving Arc Welding Problems, A. M. Candy. Iron Trade Rev., vol. 68, no. 12, Mar. 24, 1921, pp. 829–835, 19 figs. Graphs showing rate of cutting cast iron, malleable iron and steel by arc process. Tests of welds. Paper read before Am. Foundrymen's Assn.

Theory of. Phenomena of Arc Welding, O. H. Eschholz. Thirty-Ninth Gen. Meeting, Am. Electrochemical Soc., April 21–23, 1921, advance paper no. 8, pp. 59–71, 16 figs. Study of metal deposition, fusion and arc stability during electric welding.

ELEVATORS

Safety Factor for Cables. The Safety Factor in Elevator Cables (Om säkerhetsfaktorn vid hisslinor), Nils Melander. Teknisk Tidskrift (Mekanik), vol. 51, no. 1, Jan. 12, 1921, pp. 14–18. Calculation of the cables. Official regulations for safety factor. Two calculating methods are described, one of which is officially used in Prussia and is recommended by author for use also for self-operating elevators.

EMPLOYEES

Rating. Giving the Worker a Card-Index Rating, Frank H. Williams. Iron Age, vol. 107, no. 16, April 21, 1921, pp. 1033–1035, 1 fig. Practice of S. F. Bowser & Co., Ft. Wayne, Ind., manufacturers of storage systems for oil and gasoline. Employees are marked monthly on 10 points. Records form bases for production.

EMPLOYMENT MANAGEMENT

Employees Lists. What About Your Labor Force When Business Picks Up? Factory, vol 26, no. 7, April 1, 1921, pp. 831–834, 1 fig. Advises record of names, addresses and qualifications of workers applying for positions, even though at time of application they cannot be hired, with a view to insure sufficient supply of workers when production again demands.

Promotion Methods. Keeping Employees in Line for Promotion, Robert I. Clegg. Iron Age, vol. 107, no. 12, Mar. 24, 1921, pp. 761–763, 2 figs. Forms for keeping perpetual inventory of employees giving record of service, successive promotions, personal elements, outside activities, education and hobbies.

ENGINEERS

Civic Duties. Engineering in a Broader Aspect, Dean Mortimer E. Cooley. Michigan Technic, 34, no. 1, Mar. 1921, pp. 18–24. Urges organized co-operation of engineers among themselves and their participation in civic affairs as duties engineers owe to modern complex civilization.

Professional Practice. Operating Costs of Engineering Practice. Eng. News-Rec., vol. 86, no. 13, Mar. 31, 1921, pp. 542–543, 3 figs. Factors include education, capacity, class of work, and direct and indirect expenses of business. Organization chart of an engineering firm. Forms for cost keeping.

Registration. Licensing of Engineers. Jl. Am. Soc. Heat. & Vent. Engrs., vol. 27, no. 3, April 1921, pp. 326–335. Abstract covering present status of legislation for licensing of engineers in various states. Report of Publication Committee, Am. Soc. of Heat & Vent. Engrs.

Remuneration. Fees for Practicing Engineers. Eng. World, vol. 18, no. 4, April 1921, pp. 247–251, 4 figs. Progress report made by committee of Am. Assn. of Engrs.

EXCAVATORS

Mechanical. Mechanical Excavators (Les excavateurs mécaniques). Génie Civil, vol. 78, no. 9, Feb. 26, 1921, pp. 185–190, 12 figs. Survey of recent developments and uses.

EXPLOSIONS

Grain Dust. Dust Explosion at Large Chicago Grain Elevator. Eng. News-Rec., vol. 86, no. 13, Mar. 31, 1921, pp. 560–562, 2 figs. Explosion in Chicago grain elevator of Chicago & Northwestern Railway. Six men were killed and 4 injured, and about 500,000 bushels of grain were lost or damaged.

F

FACTORIES

Construction. Auto Body Plant Built of Reinforced Concrete, V. E. Winell. Concrete, vol. 18, no. 4, April 1921, pp. 160–164, 6 figs. Plan and layout of Fisher Body Ohio Co.'s plant.

Layout. Plant Layout Studies by Concrete Institute Committee. Eng. News-Rec., vol. 86, no. 12, Mar. 24, 1921, pp. 505–507, 4 figs. Report submitted at annual convention embodies description of, and comparative costs upon seven fundamental types.

FACTORY MANAGEMENT

See INDUSTRIAL MANAGEMENT.

FATIGUE

Steel Works. Fatigue and Efficiency in Iron and Steel Works—IV, H. M. Vernon. Eng. & Indus. Management, vol. 5, no. 11, Mar. 17, 1921, pp. 320–323, 2 figs. Investigations undertaken for British Industrial Fatigue Research Board. Influence of reduction of hours on rolling-mill output.

FERRONICKEL

Anomaly of Expansion. Effect of Additions in the Anomaly of Expansion of Ferronickels—Application to Ferro-Nickel-Chrome Alloys (L'action des additions sur l'anomalie de dilatation des ferronickels; application aux alliages fer-nickel-chrome), M. P. Chevenard. Comptes rendus les Séances de l'Académie des Sciences, vol. 172, no. 10, Mar. 7, 1921, pp. 594–596, 2 figs. Graphs plotted from results obtained in experiments.

FILES

Handles. Steel Files with Attachable Handles (Bezugfeilen), Karl Küssner. Betrieb, vol. 3, no. 10, Feb. 25, 1921, pp. 263–265, 7 figs. Sets forth advantages of described type and points out that for special purposes special files of this system are made with which the inside walls of steam-engine cylinders can be treated.

Revolving. Rotating Files (Rotierende Feilen), F. Karpinski. Betrieb, vol. 3, no. 10, Feb. 25, 1921, pp. 259–263, 9 figs. Describes new method using a rapidly revolving round file which, it is claimed, in many cases and particularly for special purposes, effects considerable saving in labor and greater accuracy of work.

FIREBRICK

Tests. Comparing Brick for Boiler Furnace Linings, R. C. Brierly. Combustion, vol. 4, no. 4, April 1921, pp. 20–22 and 41, 2 figs. Records of tests.

FLOW OF LIQUIDS

Short Tubes. The Flow of Liquids Through Short Tubes, Winslow H. Herschel. Proc. Am. Soc. Civil Engrs., vol. 47, no. 3, Mar. 1921, pp. 35–36. Tests on "inverted" Saybolt Universal viscosimeter. Determination of kinetic energy correction for turbulent flow from experiments of Couette. (Abstract.)

FLOW OF WATER

Measurements. Measuring Water Flow for Power Purposes. N. R. Gibson. Mech. Eng., vol. 43, no. 4, April 1921, pp. 247–248, 1 fig. Description of Gibson method and apparatus and account of its application in efficiency tests of 37,500-hp. turbines of Niagara Fall Power Co. Mean velocity of column of water in penstock by recording changes of pressure at point in pipe line when flow of water therein is gradually brought to rest by closing valve or turbine gates. Mean change or pressure recorded is measure of velocity destroyed.

FOUNDRIES

Mechanical Equipment. Pulleys Predominate in Unique Shop, Pat Dwyer. Foundry, vol. 49, no. 8, April 15, 1921, pp. 293–299, 12 figs. Practice in handling materials at foundry of Hill Clutch Co., Cleveland.

Stove. Specialty Shop Shows Versatility. Foundry, vol. 49, no. 7, April 1, 1921, pp. 265–270, 10 figs. Method and process of foundry at Famner Mfg. Co., Cleveland, manufacturers of stoves and other articles.

FREIGHT HANDLING

Bibliography. Bibliography on Freight Handling, R. F. Emerson. Gen. Elec. Rev., vol. 24, no. 4, April 1921, pp. 371–380. List of articles on general subject of material handling that have appeared in technical press since 1914.

FUELS

Ash, Fusibility of. What Constituents in Ash Cause It to Fuse, G. A. deGraaf. Coal Age, vol. 19, no. 12, Mar. 24, 1921, pp. 534–539, 5 figs. Graphs showing relation of fusing temperature of ash to percentage of silica, iron oxide and sulphur.

Calorific Value. A Proposed New Measure of Calorific Power, E. Damour. Gas J., vol. 154, no. 3021, April 6, 1921, pp. 29–30, 1 fig. Measurement of calorific power of fuels, particularly wood, peat and lignite and other substitutes for coal. Duplex-combustion producer furnace for utilization of low-grade fuels. Translated from Chimie et Industrie.

Carbocoal. The Smith Continuous System of Carbonization, George H. Thurston. Jl. Soc. Chem. Industry, vol. 40, no. 5, Mar. 15, 1921, pp. 51T–56T, 4 figs. Combination of low and high temperature carbonization. Coal is crushed to pass 3/8-in. mesh screen and is subjected to primary carbonization at temperature of about 480 deg. cent. to reduce its volatile content to uniformly low figure, whereby it is converted into friable residue containing 7 to 10 per cent of volatile matter, called semi-carbocoal. After passing through retort material is ground and mixed with suitable percentage of pitch and briquetted.

Carbozite. Carbozite (Karbozit), H. R. Trenkler. Feuerungstechnik, vol. 9, no. 11, Mar. 1, 1921, pp. 93–95, 2 figs. Said to be a refined product of lignite, wood or peat, which is not a coked material but a kind of artificial rough coal, differing in this respect from carbocoal which is a semi-coke from anthracite. The chemical and thermotechnical basic principles of process are discussed.

Colloidal. Properties and Characteristics of Colloidal Fuel, Lindon W. Bates and Haylett O'Neill. Power Plant Eng., vol. 25, no. 7, April 1, 1921, pp. 368–369, 2 figs. Graphs showing heating value of colloidal fuel of different compositions. Papers read before Royal Soc. Arts.

Domestic. The Relative Efficiency of Coal, Gas, and Electricity for Domestic Purposes, E. Marsden and (Miss) E. W. J. Fenton. New Zealand Jl. Sci. & Technology, vol. 3, nos. 5 & 6, Jan. 1921, pp. 257–270, 7 figs. It was found in tests that gas is over three times and electricity over four times more expensive for general domestic purposes than coal.

Economical Utilization. Work of the Committee on Utilization of Fuels (Travaux de la commission d'utilisation des combustibles), V. Kammerer. Bulletin de la Société d'Encouragement pour l'Industrie nationale, vol. 120, no. 3, Mar. 1921, pp. 286–301. Committee report submitted to French Ministry of Public Works. Instructions are formulated for engineers and assistants and suggestions are given in regard to economical production and utilization of steam. From Journal officiel, Feb. 20, 1921.

Recovery from Furnace Residues. Recovery of Fuel from Furnace Residues (Brennstoffgewinnung aus den Feuerungsrückständen), H. Winckel. Gesundheits-Ingenieur, vol. 44, no. 3, Jan. 15, 1921, pp. 31–32. Describes process and the Kolumbus ash separator of firm of Benno Schilde, Hersfeld, according to which the fine ashes and the large pieces of slag are sifted from the residue after which the heavy slags are separated from the light coke in a liquid of 25 to 30 deg. Baumé by means of the specific weight.

The Kolumbus Separator and the Schilde Process for the Treatment of Furnace Residues (Der Kolumbus-Separator und das Schildeverfahren zur Aufbereitung der Fererungsrückstände), H. Pradel. Elektrotechnischer Anzeiger, vol. 38, no. 30, Feb. 23, 1921, pp. 155–156, 2 figs. Describes new wet process introduced by firm of Benno Schilde, Hersfeld, Germany, in which separating liquid is used which is heavier than water, and the Kolumbus separator used in connection therewith, said to be a comparatively simple and cheap apparatus produced in three sizes. Its economical advantages are set forth.

[See also ASHES; LIGNITE; OIL FUEL; PEAT; PULVERIZED COAL.]

FURNACES, ANNEALING

Sheet. Heating Furnaces and Annealing Furnaces, W. Trinks. Blast Furnace & Steel Plant, vol. 9, no. 4, April 1921, pp. 267–272, 20 figs. Comparison of different types of sheet furnaces.

FURNACES, BOILER

Construction. Working Pressures on Furnaces, John S. Watts. Boiler Maker, vol. 21, no. 4, April 1921, pp. 112–114, 1 fig. Chart for calculating thickness of boiler furnaces to conform with requirements of principal classification societies.

Types. The Behavior of Fuels in Boiler Furnaces and Measures for Heating Them (Das Verhalten der Brennstoffe in den Kesselfeuerungen und die Massnahmen für ihre Verheizung), H. Deinlein. Zeit. des Bayerischen Revisions-Vereins, vol. 25, nos. 3 and 4, Feb. 15 and 28, 1921, pp. 17–19 and 28–39. Notes on influence of the heating value of coal on utilization of heat, draft requirement of a fuel, water content, rate of combustion, and air requirement. Discussion of horizontal-grate, step-grate and traveling-grate furnaces.

FURNACES, FORGING

Gas-Fired. The Application of Gas to Forging Furnaces. Forging & Heat Treating, vol. 7, no. 3, Mar. 1921, pp. 178–181. Results of tests. Paper read before Am. Gas Assn.

FURNACES, HEATING

Ingot. Heating Furnaces and Annealing Furnaces, W. Trinks. Forging & Heat Treating, vol. 7, no. 3, Mar. 1921, pp. 159–161, 8 figs. Critical comparison of different types of furnaces in use for heating of heavy forging ingots.

FURNACES, HEAT-TREATING

Oil Burning. Heat Treating Plant at Nash Motor Works. Iron Age, vol. 107, no. 14, April 7, 1921, pp. 895–898, 5 figs. Double carbonizing furnaces heated by oil. Automatic signal system on columns indicates furnace temperatures. Corrugated steel wall shuts heat from room.

G

GAGES

Dial. Capstan Dial Gauge. Engineering, vol. 121, no. 2881, Mar. 18, 1921, pp. 322–323, 5 figs. Indicator gages constructed by Coventry Gauge & Tool Co., England.

Precision. Precision Gauge Manufacture, Arthur G. Robson. Engr., vol. 131, no. 3404, Mar. 25, 1921, pp. 312–314, 26 figs. Jigs and fixtures employed. Example of calculations involved.

Spline. Making Inserted Spline Gauges. Machy. (Lond.), vol. 18, no. 443, Mar. 24, 1921, pp. 768–770, 6 figs. Method of milling splines and flats.

GAS ENGINES

Waste-Heat Utilization. The Utilization of Waste Heat from Gas Engines (Abwärmeverwertung bei Gasmaschinen), W. Schlachter. Oel- u. Gasmaschine, vol. 18, nos. 1 and 2, Jan. and Feb. 1921, pp. 9–12 and 22–23. Method of utilizing waste heat of cooling water.

GAS TURBINES

Developments. Gas Turbines (Ueber Gasturbinen), H. Sickel. Elektrotechnischer Anzeiger, vol. 38, nos. 32 and 33, Feb. 26 and Mar. 1, 1921, pp. 165–166 and 177–178, 3 figs. Notes on present and future development.

GEAR CUTTING

Fixtures. Efficient Fixtures Used in Gear Cutting, Douglas T. Hamilton. Can. Machy. vol. 25, no. 13, Mar. 31, 1921, pp. 33–36, 10 figs. Methods of testing truth of arbor and work.

GEAR DRIVE

Friction Losses. Running Loss and Temperature Increase in Gear Drives (Arbeitsverlust und Temperaturerhöhung bei Triebwerken), H. Bonin. Betrieb, vol. 3, no. 13, Mar. 25, 1921, pp. 377–378. It is shown that the increase in temperature of gear drive due to friction is an indication of the running losses caused by the friction, for the numerical evaluation of which, however, extended experimental data are necessary.

GEARS

Bevel. Turning Bevel Gear Blanks. Eng. Production, vol. 2, no. 26, Mar. 31, 1921, pp. 411–414, 13 figs. Production on automatic machines.

Helical. The Production of Helical Gears. Eng. Production, vol. 2, no. 27, April 7, 1921, pp. 440–443, 8 figs. Procedure in works of Citroën Gear Co., France.

Involute. Angles of Approach, Recess and Contact of Involute Gears, A. B. Cox. Am. Mach., vol. 54, no. 13, Mar. 31, 1921, pp. 559–561, 6 figs. Derivation of formulas.

Involute Gear Problems, H. E. Kitchen. Machy. (London.), vol. 18, no. 445, April 7, 1921, pp. 11–14, 6 figs. Enlarging gears without backlash. Avoidance of undercut.

The Evolution of the Involute Gear Tooth, A. Fisher. Machy. (Lond.), vol. 17, nos. 441 and 444, Mar. 10 and 31, 1921, pp. 714–718, 9 figs., and 806–809, 11 figs. Early solutions of odontoid; general rolled curve or roulette solution.

Maag System. The Maag System of Gearing—I. Engr., vol. 131, no. 3403, Mar. 18, 1921, pp. 283–285, 5 figs. Generating cutting machine. Involute teeth are generated by means of reciprocating rack cutter with straight-side teeth.

Production System. Quantity Production in a Gear Shop—I, Fred R. Daniels. Machy. (N. Y.), vol. 27, no. 8, April 1921, pp. 763–766, 10 figs. Practice of Dittmer Gear & Mfg. Corp., Lockport, N. Y., in manufacture of gears for tractors, trucks and automobiles.

Worm. Calculating Chart for Worm Gear as a Basis for Standardization (Berechnungstafel fus Schneckengetriebe als Grundlage fur die Normung derselben), Friedrich Woltzendorff. Betrieb, vol. 3, no. 9, Feb. 10, 1921, pp. 234–238, 2 figs. Recommendations for standardization of worm gear supplementary to those published in same journal (vol. 14, no. 2, 1920). An improved chart is presented and calculation thereof explained.

GOLD METALLURGY

Antimonial Ore Treatment. Treatment of Antimonial Gold Ore at the Globe and Phoenix Gold Mine, Southern Rhodesia, V. E. Robinson. Jl. Chem., Metallurgical & Min. Soc., vol. 21, no. 7, Jan. 1921, pp. 117–119. Owing to stibnite present and also possibly to ferrous iron, tailing cannot be treated directly by cyanide, but if it be allowed to partially oxidize by weathering, it becomes amenable to cyaniding.

GRINDING

Cylindrical. Points to Consider in Cylindrical Grinding, W. H. Chapman. Can. Machy., vol. 25, no. 13, Mar. 31, 1921, pp. 41–44, 2 figs. Factors which determine wheel-wearing action. Laws relating to draw-in and traversed cuts. Production costs.

Fixtures. The Use of Special Fixtures in Grinding Operations, Ellsworth Sheldon. Am. Mach., vol. 54, no. 13, Mar. 31, 1921, pp. 545–548, 14 figs. Use of gear as chuck upon which to finish another gear. Grinding tapers without traverse.

GRINDING MACHINES

British-Built. The Coventry Centreless Grinder, H. A. Dudgeon. Machy. (Lond.), vol. 17, no. 444, Mar. 31, 1921, pp. 789–792, 14 figs. Machines manufactured by B.S.A. Tools, Birmingham.

German. Modern Grinding Machines (Neuere Schleifmaschinen), W. Pockrandt. Zeit des Vereines deutscher Ingenieure, vol. 65, no. 12, Mar. 19, 1921, pp. 289–291, 37 figs. on 2 supp. plates. Cylindrical surface and piston-ring grinding machines built by Reinecker (Chemnitz).

H

HACK-SAWING MACHINES

Automatic. Automatic Hack Sawing Machine. Machy. (Lond.), vol. 18, no. 443, Mar. 24, 1921, pp. 784–785, 4 figs. Manufactured by Edward G. Herbert, Manchester, England.

HANDLING MATERIALS

Electrically Operated Machinery. The Field for Electrically Operated Material Handling Machinery, F. T. Smith. Gen. Elec. Rev., vol. 24, no. 4, April 1921, pp. 361–365, 6 figs. Typical installations.

Freight-Handling Devices. A Brief Directory of Material Handling Apparatus, R. H. McLain. Gen. Elec. Rev., vol. 24, no. 4, April 1921, pp. 306–317, 46 figs. Descriptions and illustrations of freight-handling devices which are suitable for handling different classes of material through horizontal and vertical motion over long and short distances.

Routing. The Application of Power-Driven Machinery to the Horizontal Transference of Miscellaneous Freight, F. A. Jackson. Gen. Elec. Rev., vol. 24, no. 4, April 1921, pp. 325–330, 6 figs. Fundamental principles of routing that must be observed to secure efficient system for transferring miscellaneous freight or material within building.

HARDNESS

Testing. The Study of Bar Hardness Tests (Étude sur l'essai de dureté a la bille), René Guillery. Mémoires et Compte rendu des Travaux de la Société des Ingenieurs Civils de France, vol. 73, nos. 10, 11 and 12, Oct.-Dec. 1920, pp. 591–606, 22 figs. partly on supp. plate. Research on the elimination of time elements in Brinell tests. Apparatus measuring by impact given by hammer.

HEATING AND VENTILATION

Fire Hazards. Fire Hazards Connected with Heating and Ventilating Work, Ira H. Woolson. Jl. Am. Soc. Heat. & Vent. Engrs., vol. 27, no. 3, April 1921, pp. 286–292. Suggestions based upon statistics of insurance losses paid by companies reporting to Actuarial Bur. of Nat. Board of Fire Underwriters for five years 1915–1919 inclusive.

HEATING, ELECTRIC

Heating and Cooking Apparatus. The Status of Electric Heating and Cooking Apparatus (Der Stand der elektrischen Heiz- und Kochapparate), H. Wintermeyer. Elektrotechnischer Anzeiger, vol. 38, no. 44, Mar. 19, 1921, pp. 253–258, 4 figs. Review of foreign and domestic patented improvements.

Switzerland. The Employment of Electricity for Heating (Die Verwendung der Elektrizität in der Heizungstechnik), R. Gautschi. Gesundheits-Ingenieur, vol. 44, no. 2, Jan. 8, 1921, pp. 13–17, 6 figs. Describes construction and operation of electric central and separate heating installations in Switzerland. Comparison of the cost of heating with use of black and white coal. Notes on hot-water heating operated with night current; heat storage tanks, electrically heated high-pressure boilers, etc.

HEAT TRANSMISSION

Building Materials. The Heat Conduction Coefficients of Building and Insulating Materials and the Coefficient of Permeability of New Building Types (Die Wärmeleitzahl von Bau und Isolierstoffen und die Wärmedurchlässigkeitzahl neuer Bauweisen), Osc. Knoblauch, E. Raisch and H. Reiher. Gesundheits-Ingenieur, vol. 43, no. 52, Dec. 25, 1920, pp. 607–623, 4 figs. Part I gives results of experiments carried out in years 1912–1920 for determination of heat conductivity of building and insulating materials. Part II gives results of tests carried out consecutively since 1918 on experimental houses for determination of permeability of certain wall constructions. The most important conclusions are summarized. See also same journal, vol. 44, no. 9, Feb. 26, 1921, pp. 100–101. (Remarks by H. Chr. Nussbaum.)

Radiation. Present Status of the Constants and Verification of the Laws of Thermal Radiation of a Uniformly Heated Inclosure, W. W. Coblentz. U. S. Dept. of Commerce, Sci. Papers, Bur. of Standards, no. 406, Dec. 20, 1920, 48 pp. Examination into various determinations and methods employed in determining radiation constants by different experimenters. Comparison of accuracy of results obtained therewith.

HELICOPTERS

Berliner. The New Berliner Helicopter. Aviation, vol. 10, no. 13, Mar. 28, 1921, pp. 393, 2 figs. Helicopter invented by H. A. Berliner of Washington, D. C.

Modern Types. Independent Sustentation of an Aeroplane in Air (Vers la sécurité: la sustentation indépendante), M. Lamé. Aérophile, vol. 29, nos. 3 & 4, Feb. 1–15, 1921, pp. 46–49, 6 figs. Details of modern helicopters—Crocker-Hewitt, Alérion, Pescara Oehmichen.

Oehmichen. Flight Tests Performed with Oehmichen Helicopter in January 1921 (Vols d'essai realisés avec un héliçptère libre monté, système Oehmichen (janvier 1921). Génie Civil, vol. 78, no. 11, Mar. 12, 1921, pp. 237–238, 1 fig. Apparatus is provided with two 2-bladed propellers of 6.40 meters diameter rotating in opposite directions in same horizontal plane.

Study of. The Helicopter—I, M. A. S. Riach. Aeronautics, vol. 20, no. 389, Mar. 31, 1921, pp. 223–224, 1 fig. Technical study. (To be continued.)

HOISTS

Skip. Provisions that Enable the Skip Hoist at Coal Mines to Give Maximum Service, Andrews Allen and John A. Garcia. Coal Age, vol. 19, no. 12, Mar. 24, 1921, pp. 529–533, 4 figs. Where skip hoisting is employed bottom layout differs radically from that used with cage hoisting. Although four kinds of dumps are available rotary is variety most generally installed. Paper read before Am. Inst. Min. & Metallurgical Engrs.

HOUSE ORGANS

Editorial Policies. Industrial Publicity and the House Organ, Charles E. Carpenter. Indus. Management, vol. 61, no. 7, April 1, 1921, pp. 247–249. Developments of industrial publicity. Note on editorial policies to follow in house organs.

HOUSES, CONCRETE

Construction. Recommended Practice for Concrete House Construction. Eng. & Contracting, vol. 55, no. 12, Mar. 23, 1921, pp. 278–279. Report of committee on concrete houses, Am. Concrete Inst.

Fireproofing. Fireproofing a Concrete Block House, Wharton Clay. Eng. World, vol. 18, no. 4, April 1921; pp. 275–276. Recommendation of Nat. Conference of concrete house construction.

Ingersoll-Rand System. How the Ingersoll-Rand Company is Solving Its Housing Problem with Concrete. Concrete Age, vol. 33, no. 6, Mar. 1921, pp. 18–23, 6 figs. Wooden forms are set up for making complete house in one operation.

Machine-Made. Machine-Made Reinforced Concrete Houses and Other Structures, F. G. Engholm. Can. Engr., vol. 40, no. 13, Mar. 31, 1921, pp. 337–342, 6 figs. Details of machine-made parts for concrete structures.

HYDRAULIC TURBINES

Design. The Modern Hydraulic Turbine, Frank H. Rogers. Jl. Engrs. Club of Phila., vol. 38–3, no. 195, Mar. 1921, pp. 77–90, 25 figs. Modern requirements. Tests on models as adjunct to design. General and special features of design.

Development. The Present Trend of Turbine Development, Lewis F. Moody. Mech. Eng., vol. 43, no. 4, April 1921, pp. 235–244, 17 figs. Also Jl. Engrs. Club of Phila., vol. 38–3, no. 195, Mar. 1921, pp. 106–123, 25 figs. Brief survey of past history and recent progress, together with discussion of theoretical problems involved in hydraulics of modern high-speed turbine, notably determinations of turbine and pump efficiencies as related to specific speed.

Efficiency. Economic Importance of the Efficiency of Hydraulic Turbines for New Construction and Reconstruction (Wirtschaftliche Bedeutung des Wirkungsgrades der Wasserturbinen für Entscheidungen beim Neubau und Umbau), H. Leiner. Zeit. des Vereines deutscher Ingenieure, vol. 65, no. 9, Feb. 26, 1921, pp. 222–224. Development of equations to be considered in the determination of economic efficiency of turbines. It is shown that old installations have for the most part lost their significance from an economic standpoint. In the case of new construction, selection of construction type should be made with due regard to economic influence of its efficiency.

Maximum Efficiency of Turbines (Sur le rendement maximum des turbines), M. de Sparre. Comptes rendus des Séances de l'Académie des Sciences, vol. 172, no. 10, Mar. 7, 1921, pp. 561–564. Formulas.

Thermometric Method for Measuring Efficiency of Hydraulic Turbines (Sur une méthode thermométrique de mesure du rendement des turbines hydrauliques), L. Barbillion and A. Poirson. Houille Blanche, vol. 19, nos. 47 and 48, Nov.–Dec. 1920, pp. 217–221, 2 figs. Principle of method consists in assuming that quantity of heat corresponding to energy loss is employed in heating water.

Efficiency Tests. The Application of a New Method of Water Measurement in the Efficiency Tests of the 37,500 H.P. Turbines of the Niagara Falls Power Company, N. R. Gibson. Jl. Engrs. Club of Phila., vol. 38–3, no. 195, Mar. 1921, pp. 90–101, 18 figs. Description of Gibson method and apparatus for measuring flow of water in penstocks. Comparison of volumetric and Gibson measurements.

Speed Regulation. Speed Regulation of the Hydraulic Turbine, Raymond D. Johnson. Mech. Eng., vol. 43, no. 4, April 1921, pp. 245–246 and 248, 2 figs. Also Jl. Engrs. Club of Phila., vol. 38–3, no. 195, Mar. 1921, pp. 101–106, 7 figs. Notes on design of surge tanks. Graph showing typical variations of water level in both tank and standpipe of differential regulator.

HYDROELECTRIC PLANTS

California. An Emergency Hydroelectric Plant, Geo. H. Bragg. Jl. Electricity & Western Industry, vol. 46, no. 7, April 1, 1921, pp. 340–342. Construction work on Pacific Gas & Elec. Co. of California during 1920 power shortage.

Canada. Canada's Superpower Zone, Robert G. Skerrett. Sci. Am., vol. 124, no. 13, Mar. 26, 1921, pp. 246 and 258, 1 fig. Scheme worked out by Ontario hydroelectric power commission.

Hydro-Electric Progress in Canada During Past Year, J. B. Challies. Contract. Rec., vol. 35, no. 12, Mar. 23, 1921, pp. 298–301. In 1920, 650,000 hp. was completed or under construction. Active government development of power resources. Canada next to Norway in amount developed.

France. Utilization of the Hydraulic Energy in the Vienne River in West of France (Usines électriques de la Société des Forces motrices de la Vienne), Auguste Pawlowski. Génie Civil, vol. 78, no. 14, April 2, 1921, pp. 285–289, 10 figs. Construction of three plants, one of 6000 hp., one of 8000 hp. and one of 9000 hp.

Electrical Features. Electrical Features of Hydro-Electric Power, David Barker Rushmore. Jl. Engrs. Club of Phila., vol. 38–3, no. 195, Mar. 1921, pp. 123–129. Enumeration of electrical apparatus involved.

Queenston-Chippewa Project, Ontario. 50,000-Hp. Wheels for 500,000-Hp. Plant, E. T. J. Brandon. Elec. World, vol. 77, no. 13, Mar. 26, 1921, pp. 697–699, 6 figs. Five 45,000-kva. generators already on order for Queenston-Chippewa project in Ontario. Unit system followed for electrical layout. Generators set below floor level. Control pedestals at generators.

Sweden. The Glomfjord Hydroelectric Plant, Sweden (Glomfjord Kraftanlæg), Ragnvald Lie. Teknisk Ukeblad, vol. 68, nos. 5 and 6, Feb. 4 and 11, 1921, pp. 50–53 and 61–65, 10 figs. The available volume of water is 25 cu.m. per sec. and is supplied from a number of lakes located in high altitudes; the entire water supply is 585 million cu.m., the head, 450 m. At present six turbines for 160,000 hp. are to be installed, of which 25,000 hp. are to be held as reserve. Notes on preliminary construction work.

Switzerland. New Hydroelectric Plant under Construction in the Canton of Grisons, Switzerland (Die Landquartwerke der "Bündner Kraftwerke"), R. Moor. Schweizerische Bauzeitung, vol. 77, no. 12, Mar. 19, 1921, pp. 127–130, 7 figs. Details of Kloster-Kublis power plant designed by and being constructed under supervision of writers. Plant is first stadium of large project for harnessing Landquart river and its tributaries.

I

ICE PLANTS

Electric vs. Steam Drive. Electrification of the Ice Industry, Donald Cole. Ice & Refrigeration, vol. 60, no. 3, Mar. 1921, pp. 175–176. Comparison of manufacturing costs in electrically driven and steam-driven ice plants.

IGNITION

Coil Sparks. Phenomena of the Ignition of Gaseous Mixtures by Induction Coil Sparks, John David Morgan and Richard Vernon Wheeler. Jl. Chem. Soc., vols. 119 & 120, no. 701, Mar. 1921, pp. 239–250, 10 figs. Experiments on different mixtures of methane and air.

INDICATORS

Steam-Engine. Determination of the Continuous Output of Reciprocating Steam Engines (Die Feststellung der Dauer-Betriebsleistung von Kolbendampfmaschinen). Kali, vol. 15, no. 4, Feb. 15, 1921, pp. 53–58, 6 figs. Power meter and load indicator with recording device constructed by Anton Böttcher, Hamburg, and power meter by Gümbel, Charlottenburg.

INDUSTRIAL MANAGEMENT

Attitude of Organized Labor. Union Labor and the Enlightened Employer, Samuel Gompers. Indus. Management, vol. 61, no. 7, April 1, 1921, pp. 235–239. Attitude of organized labor toward management, open shop crusade, collective bargaining, and present day economic problems.

Accident Prevention. Safety and Accident Prevention, Fred G. Lange. Indus. Management, vol. 61, no. 7, April 1, 1921, pp. 257–259. Explains accident prevention as phase of industrial management.

Central Control. Central Control System in the Franklin Plant, Franklin D. Jones. Machy. (N. Y.), vol. 27, no. 8, April 1921, pp. 745–749, 6 figs. Also in Machy. (Lond.), vol. 18, no. 445, Apr. 7, 1921, pp. 1–5, 6 figs. System employed by H. H. Franklin Mfg. Co., for regulating output according to demand, and for controlling manufacturing operations by mechanical boards or charts and pneumatically operated dispatch system.

Developments. The Evolution of Industrial Management, Henry R. Towne. Indus. Management, vol. 61, no. 7, April 1, 1921, pp. 231–233. Review of developments during last 30 years.

Thirty Years of Management Literature, John R. Dunlap. Indus. Management, vol. 61, no. 7, April 1, 1921, pp. 279–283 and 311. Survey of developments in industrial management. (To be continued.)

Gantt's Method of Inquiry. Principles of Industrial Philosophy, Walter N. Polakov. Mech. Eng., vol. 43, no. 4, April 1921, pp. 249–252 and (discussion) pp. 253–254, 5 figs. Gantt's method of inquiry into co-relation of social needs and industrial services. Application and influence of principles enunciated by Gantt.

Incentives to Workers. Incentives to Better Workmanship Appeal to a Variety of Instincts, Norman G. Shidle. Automotive Industries, vol. 44, no. 13, Mar. 31, 1921, pp. 712–714. Plan of classification of employees and opportunities offered for their advancement at plant of Sperry Gyroscope Co.

Instruction Sheets. Proposals for New Factory Instruction Sheets (Entwürfe neuer Betriebsblätter), Betrieb, vol. 3, no. 12, Mar. 10, 1921, pp. 84–85. Proposals of Committee for Economic Production for instruction sheet for the handling and erection of machine tools.

Production Systems. Making Pay Envelopes Reflect Merit, R. A. Ilg. Factory, vol. 26, no. 7, April 1, 1921, pp. 837–839, 3 figs. Production records are posted where employees can see them. Bulletin board causes workman's natural pride to show itself in increased production. Bonuses are paid for increased production.

Production in a General Engineering Shop. Eng. Production, vol. 2, no. 25, Mar. 24, 1921, pp. 385–390, 16 figs. Works and methods of Messrs. Peter Brotherhood, Ltd., London.

The Trend Toward Automatic Production, A. L. DeLeeuw. Indus. Management, vol. 61, no. 7, April 1, 1921, pp. 251–255. Developments in production systems during last 30 years.

Works Organization. Eng. Production, vol. 2, no. 25, Mar. 24, 1921, pp. 391–395, 15 figs. Production systems of British automobile manufacturer.

Routing Materials. Co-Ordinating the Industrial Plant Through Intra-Factory Transportation, W. F. Merrill. Indus. Management, vol. 61, no. 7, April 1, 1921, pp. 261–265, 5 figs. Economics of intra-factory transportation.

Toolroom Organization. Distribution of Tools (Die Werkzeugausgabe), Th. Damm. Betrieb, vol. 3, no. 10, Feb. 25, 1921, pp. 282–284, 3 figs. Fundamental aspects are discussed, and practical equipment, arrangements and organization methods are suggested which have proved successful in practice.

INDUSTRIAL RELATIONS

American Industries. What America Faces, Herbert Hoover. Indus. Management, vol. 61, no. 7, April 1, 1921, pp. 225–229. Review and forecast of fundamental relationships between employer and employee. It is pointed out that although there are no conflicts of interest between employee and employer, there are also "wide areas of activity in which their interests should coincide, and it is the part of statesmanship on both sides to organize this identity of interest in order to limit the area of conflict."

Electrical Construction Industry. National Labor Council for the Electrical Construction Industry. Monthly Labor Rev., vol. 12, no. 3, Mar. 1921, pp. 126–127. Plan adopted in April 1920, by Nat. Assn. of Elec. Contractors and Dealers and Nat. Brotherhood of Elec. Workers. Purposes of Council are said to be "promotion of peace and harmony in electrical industry, the adjudication of disputes between employers and employees, the establishment of friendly relations between all parties interested, which should ultimately result in the elimination of distrust, suspicion, and the wasteful methods of the old-fashioned strikes and lockouts."

Pennsylvania Railroad. Joint Reviewing Committee of the Pennsylvania Railroad System. Monthly Labor Rev., vol. 12, no. 3, Mar. 1921, pp. 122–125. Duty of Reviewing Committee is "amicable settlement, by joint conference, of all controversial questions affecting engine and train service men." Plan was adopted at meeting held on Dec. 29, 1920 by representatives of employees and representatives of administrative force of railroad.

Plans. Industrial Relations Work Pays, James W. Brown. Iron Trade Rev., vol. 68, no. 13, Mar. 31, 1921, pp. 906–908. Outlines plan to promote family spirit in industrial life of all employees. Paper read before Am. Foundrymen's Assn.

Shop Councils. One Year of the Shop Council System in Germany. Am. Mach., vol. 54, no. 16, April 21, 1921, pp. 682. Occasional strikes, steady rise in wages, unwarrantable interference and failure in increasing production are conditions reported by managers of industrial works.

INDUSTRIAL TRUCKS

Electric. Electric Vehicles for Railway Cartage Work. Ry. Gaz., vol. 34, no. 11, Mar. 18, 1921, pp. 426–427 and 429, 5 figs. Trucks used by Great Northen Ry., England. Data on running costs.

Electric Trucks and Industrial Locomotives. Engr., vol. 131, nos. 3403 and 3404, Mar. 18, and 25, 1921, pp. 290–292 and 294, 10 figs., and 318–319, 6 figs. Typical British designs.

INTERNAL-COMBUSTION ENGINES

Compensation Gear. Tappet Clearance Compensating Gear. Engineering, vol. 111, no. 2882, Mar. 25, 1921, pp. 352–353, 5 figs. Gear providing for automatic cancellation of effects of expansion differences.

Design. The Internal Combustion Engine—Fuel, Valves and Ignition, A. W. Bradbury. Trans. Inst. Mar. Engrs., vol. 32, Feb. 1921, pp. 381–404, 14 figs. Design features of typical engines.

Thermodynamic Cycles in Relation to the Design and Future Development of Internal-Combustion Engines, William J. Walker. Jl. Instn. Mech. Engrs., no. 10, Feb. 1921, pp. 1235–1261 and (discussion) pp. 1261–1311, 24 figs. Classification of engine types. Variable specific heat relationship between maximum pressure and mean effective pressure in variable volume cycle. Study based on results obtained in tests of internal-combustion engine, including those operated by coal-gas and producer-gas, oil engines of Diesel and semi-Diesel types, hot-bulb engines and also high-speed gasoline engines of automotive class.

Exhaust-Gas Utilization. The Carbonization of Wood by the Exhaust Gases from Internal Combustion Engines (La carbonisation du bois par l'échappement des moteurs à explosion), Louis Tissier. Chimie & Industrie, vol. 5, no. 2, Feb. 1921, pp. 136–142, 1 fig. Tissier furnace. Exhaust gases pass through pile of wood. High temperature of gases carbonizes wood.

Uses. Internal Combustion Engines, C. S. Darling. Beama, vol. 8, no. 3, Mar. 1921, pp. 248–263, 5 figs. General considerations determining use with reference to power generation.

[See also AEROPLANE ENGINES; AUTOMOBILE ENGINES; DIESEL ENGINES; GAS ENGINES; GAS TURBINES; LUBRICATION, INTERNAL-COMBUSTION ENGINES; OIL ENGINES; SEMI-DIESEL ENGINES; TRACTOR ENGINES]

IRON

Corrosion-Resisting. The Effect of Copper and Silver Salts on the Corrosion of Iron by Acids, Oliver P. Watts and Harold C. Knapp. Thirty-Ninth Gen. Meeting, Am. Electrochemical Soc., April 21–23, 1921, advance paper no. 14, pp. 135–140, 1 fig. Record of tests on corrosion of iron by sulphuric acid in absence or presence of various salts of copper and silver. Conclusion drawn is that in general corrosion is stimulated by presence of these salts.

L

LABOR

Hours of Work. One Year of the Eight-Hour Law in Sweden. Monthly Labor Review, vol. 12, no. 3, Mar. 1921, pp. 97–98. "Confronted with the unsatisfactory results" of 8-hour law Swedish Government has commissioned Royal Social Board to investigate and report upon advisability of modification of its provisions.

LATHE TOOLS

Turret Lathes. Tooling the Modern Turret Lathe, A. H. Lloyd. Can. Machy., vol. 25, no. 12, Mar. 24, 1921, pp. 33–36, 9 figs. Tools for machining magneto cam case, gun-metal bush and motorcycle flywheel.

LATHES

Bench. Tools and Methods for Manufacturing Precision Bench Lathes—II. Machy. (N. Y.), vol. 27, no. 8, April 1921, pp. 751–754, 9 figs. Practice of S. A. Potter Tool & Machine Works, New York City, in manufacture of bench lathes.

German Automatic. German Automatic Lathes (Der deutsche Automatenbau), Ph. Kelle. Der praktische Maschinen-Konstrukteur, vol. 54, no. 6, Feb. 10, 1921, pp. 17–32, 47 figs. Details of various types of lathes for the machining of screws and similar parts. It is pointed out that whereas most German automatic lathes are copied from American systems, the described screw lathe is a purely German system constructed exclusively in Germany.

Railway Wheel. A new 5-ft. Railway Wheel Lathe. Machy. (Lond.), vol. 18, no. 443, Mar. 24, 1921, pp. 771–773, 3 figs. Manufactured by W. G. Armstrong, Whitworth & Co., Manchester, England.

Standards. Report of the German Industry Committee on Standards (Mitteilungen des Normenausschusses der Deutschen Industrie). Betrieb, vol. 3, no. 12, Mar. 10, 1921, pp. 159–161, 4 figs. Proposal of the Board of Directors for speed cones. Proposed standards for hand wheels.

Staybolt. A Lathe for Staybolts (Eine Stenbolzen-Drehbank), W. Daevessen. Betrieb, (special no.), vol. 3, no. 11, Mar., 1921, pp. 300–301, 1 fig. Special lathe constructed by the Magdeburger Machine-Tool Factory Corp.

Turret. Large Turret Lathes (Gross-Revolverbänke) Fritz Heilborn. Betrieb (special no.), vol. 3, no. 11, Mar., 1921, pp. 297–299, 3 figs. Type manufactured by Böhringer Bros., Göppingen, Germany, for machining of crankcases. The machining of crankcases of 380 mm. diam. and 200 m. breadth takes about 35 minutes.

LAUNCHING

Tallows for. Some Experiments on Tallows Used for Launching Ships, J. J. King-Salter. Engineering, vol. 111, no. 2883, April 1, 1921, pp. 405–407, 2 figs. Curves of compression strength and hardness factors against temperatures for various natural tallows. Paper read before Instn. Naval Architects.

LIGNITE

Utilization. New Recommendations for the Rational Utilization of Bituminous Wet Lignites (Neue Vorschläge zur rationellen Ausnutzung bituminöser nasser Braunkohle), Gh. Limberg. Braunkohle, vol. 19, no. 46, Feb. 26, 1921, pp. 570–574, 1 fig. Notes on distillation at low temperature for the production of low-temperature coke. (Concluded).

Germany's Brown Coal, Robert G. Skerrett. Sci. Am., vol. 124, no. 16, April 16, 1921, pp. 304 and 315, 2 figs. Industrial utilization of swamp muck.

LOCOMOTIVE BOILERS

Heavy Freight Locomotives. Details of New Santa Fe Locomotive Boilers. Boiler Maker, vol. 21, no. 4, April 1921, pp. 95–100 and 124, 7 figs. Conical design built for working pressure of 195 lb. per sq. in. Outside diameter of course is 88 in., while diameter of rear course is 100 in. Firebox is 132 in. long and 96 in. wide.

LOCOMOTIVES

Bearings. Shop Methods of Casting Locomotive Bearings, J. V. Hunter. Am. Mach., vol. 54, no. 14, April 7, 1921, pp. 590–596, 23 figs. Comparison of methods used in shops of Wabash Railroad, Big Four System and Chicago & Alton Railway.

Belgian. The New "Consolidation" Locomotives of the Belgian State Railways, E. Minsart. Bul. Int. Ry. Assn., vol. 3, no. 3, Mar. 1921, pp. 305–311, 3 figs. Dimensions: Diameter of cylinder, 24 in.; piston stroke, 28 in.; boiler pressure, 199.12 lb.; inside diameter of boiler, 5 ft. 8 in.; heating surface of fire-box, 149.62 sq. ft.; total wheel base of engine, 27 ft. 11 in.

British. 4-6-4 Type Tank Locomotive for the Furness Railway. Engineering, vol. 111, no. 2882, Mar. 25, 1921, pp. 356–357, 6 figs. partly on supp. plate. Characteristics: Cylinders, 19½ in. by 26 in.; wheels, coupled diameter, 5 ft. 8 in.; wheelbase, coupled, 13 ft. 3 in.; heating surface tubes, 1850 sq. ft.; heating surface fire-box, 153 sq. ft.

New Express Locomotives for the Bengal-Nagpur Railway. Ry. Gaz., vol. 34, no. 11, Mar. 18, 1921, pp. 428–429, 3 figs. Characteristics: Type, 4-6-0; cylinders, 21½ in. diameter by 26-in. stroke; diameter of driving wheels, 6 ft. 1½ in.; total evaporative surface, 1259 sq. ft.; superheating surface, 250 sq. ft.; tractive force, 23,554 lb.

Powerful Side Tank "Ghat" Locomotives for the Great Indian Peninsula Railway. Ry. Gaz., vol. 34, no. 12, Mar. 25, 1921, pp. 475, 1 fig. Characteristics: Cylinders, diameter, 22 in.; piston stroke, 26 in.; wheelbase, coupled wheels, 15 ft. 6 in.; weight on coupled wheels, 79 tons 16 cwt.

Coaling Stations. Coaling Station for City Engine Terminal: O. & R. R. Eng. News-Rec., vol. 86, no. 16, April 21, 1921, pp. 673–674, 3 figs. Three grades of coal. Operator handles chutes. One hoist service for coal and sand. Large sand drying plant.

Design. Locomotives for Operation on Curves (Bogenläufige Lokomotiven), F. Meineke. Zeit. des Vereines deutscher Ingenieure, vol. 65, nos. 8 and 9, Feb. 19 and 26, 1921, pp. 191–194 and 217–221, 19 figs. Notes on arrangement of the axles in special frames or in main frames; description of the most important modern locomotive types; the Mallet locomotive; the Krauss truck; the Gölsdorf axle arrangement; the Klien-Lindner axles; American 2C1 and 2D1 locomotives; 1D1 four-cylinder compound locomotives of the Saxon State Railroad. Selection of suitable construction types.

Internal-Combustion. Internal Combustion Locomotives for Railway Service. Ry. Gaz., vol. 34, no. 11, Mar. 18, 1921, pp. 440–443, 4 figs. Light locomotives built by Ruston & Hornsby, England. Two types, one 10 hp. and one 20 hp.

Mine, Internal-Combustion. German Internal-Combustion Locomotives. Gas & Oil Power, 16, no. 187, April 7, 1921, pp. 109–110, 3 figs. Mine locomotive built by Deutz Gas Engine Co.

Reconstruction. Locomotives and Locomotive Terminals. Mech. Eng., vol. 43, no. 4, April 1921, pp. 255–258 and 272. Salient points brought out in discussion of papers on increasing capacity of old locomotives and modernizing locomotive terminals, presented at Am. Soc. Mech. Engrs. 1920 annual meeting.

Stoker-Fired. Operating Economies in Longe Runs, F. M. Nellis. Ry. Rev., vol. 68, no. 14, April 2, 1921, pp. 535–536. Experience of Erie Railroad.

Throttle Valve for. Design of an Improved Locomotive Throttle Valve, W. J. Knox. Ry. Mech. Engr., vol. 95, no. 4, April 1921, pp. 216–218, 10 figs. Type developed by Buffalo, Rochester & Pittsburgh Railroad.

LUBRICANTS

Drilling. Investigation of Lubricants for Drilling (Untersuchung von Bohrölen), Georg Schlesinger and Eugen Simon. Werkstattstechnik, vol. 15, no. 5, Mar. 1, 1921, pp. 140–143, 6 figs. Results of investigation carried out at the experimental bureau for machine tools of the Berlin Technical Academy.

LUBRICATING OILS

Reclamation. The Reclamation of Lubricating Oils (La régéneration des huiles de graissage). Bulletin technique du Bureau Veritas, vol. 3, no. 3, Mar. 1921, pp. 64–67, 3 figs. Salaün apparatus for reclamation of lubricating oils.

Separators for. Oil Separator (Oljereningsseparatorer). Teknisk Tidskrift (Mekanik), vol. 51, no. 2, Feb. 9, 1921, pp. 37–40, 2 figs. Description of the Alfa Separator AVO. Advantages of centrifugal separation over older processes are pointed out.

Tests. Tests on Lubricating Oil for Two-Stroker Cycle Semi-Diesel Engines, T. M. Robie. Power, vol. 53, no. 15, April 12, 1921, pp. 588–590, 2 figs. Graphs showing influence of temperature on viscosity of lubricating oils.

LUBRICATION

Cylinders. The Lubrication of Steam Cylinders with Oil Emulsions (Schmierung von Dampfzylindern mit Oelemulsionen), H. Hilliger. Zeit. des Vereines deutscher Ingenieure, vol. 65, no. 10, Mar. 5, 1921, pp. 248–249, 5 figs. Describes methods and gives results of tests with oils and emulsions, properties and composition of which are given.

Internal-Combustion Engines. The Lubrication of Internal-Combustion Engines (Zur Schmierung der Verbrennungskraftmaschinen), H. Praetorius. Motorwagen, vol. 24, no. 5, Feb. 20, 1921, pp. 90–93, 4 figs. Lubricating pumps of Natter Apparatus Construction Co., Ltd., Feuerbach.

M

MACHINE SHOPS

England. Machine Tool Works at Broadheath Engr., vol. 131, no. 3405, April 1, 1921, pp. 346–347 and 350, 12 figs. Layout of shops. Details of driving arrangements.

MACHINE TOOLS

Efficiency Tests. Factory Valuation of Machine Tools (Zur betriebstechnischen Wertung der Werkzeugmaschine), Alfred Freund. Betrieb (special no.), vol. 3, no. 11, Mar. 1921, pp. 319–322. Description and results of efficiency tests carried out on the shaping machines of the F. C. Nischwitz Machine Tool Factory, Halle.

Hydraulic. Hydraulic Machine Tools. Managing Engr., vol. 7, no. 11, Mar. 1921, pp. 201–203, 5 figs. Forging press, cold plate shears, plate flanger, marine boiler riveter, etc. Paper read before Gloucestershire Eng. Soc.

Leipzig Exhibition. Performances of Standard Machine Tools (Einige Leistungen normaler Werkzeugmaschinen), Heinrich Sauter. Betrieb (special no.), vol. 3, no. 11, Mar. 1921, pp. 285–294, 28 figs. Description of principal exhibits.

Reconstruction. Reconstruction of Old Machine Tools for Special Tasks (Umbau alter Werkzeugmaschinen für Spezialarbeiten), Paul Krieg. Betrieb, vol. 3, no. 10, Feb. 25, 1921, pp. 270–272, 2 figs. It is shown that even in the case of mass production it is not always necessary to procure new and expensive special machines, and that equally good or better results can be obtained through skillful reconstruction of existing machines. Example is given of a lathe for copper locomotive-boiler staybolt.

Standardization. Practical Formulas for Small Construction Parts in the Construction of Machine Tools (Praktische Formeln für kleinere Konstruktionsteile im Werkzeugmaschinenbau), H. Lambrette. Der praktische Maschinen-Konstrukteur, vol. 54, no. 8, Feb. 24, 1921, pp. 33–35. It is suggested that formulas given might be of aid in standardization.

Steels for Parts. Steels for Machine Tool Parts, Robert M. Taylor. Machy. (N. Y.), vol. 27, no. 8, April 1921, pps. 770–771. Table of required properties of steel for machine tool parts. (Abstract.) Paper read before Am. Soc. for Steel Treating.

Stud-Inserting Attachment. A New Type of Stud Inserting Machine (Ein neuartiger Stiftschraubeneinzieher), Christian Weiherer. Der praktische Maschinen-Konstrukteur, vol. 54, no. 7, Feb. 17, 1921, pp. 31–33, 3 figs. Describes patented device, called "Rekord," which has been successfully employed in the M.A.N. works in connection with a radial drill for screwing studs in cylinders.

Testing Laboratory. A Testing Laboratory for Machine Tools (Ein Versuchsfeld für Werkzeugmaschinen), Willi Mitan. Zeit. des Vereines deutscher Ingenieure, vol. 65, no. 11, Mar. 12, 1921, pp. 268–269, 4 figs. The electrically driven testing laboratory of the Fritz Werner Corp., Berlin-Marienfelde, for testing the power requirements and efficiency of machine tools and other necessary tools and auxiliary equipment, is provided with four testing motors and a switchboard with measuring instruments and is fed from a converter installation of 30 kw.

MACHINERY

Production Statistics. Statistics of Production in Machine Construction (Produktionsstatistik im Maschinenbau), H. Rech. Betrieb, vol. 3, no. 9, Feb. 10, 1921, pp. 221–230, 3 figs. 2 on supp. plate.

Deals with organization for collecting statistics of production instituted by Assn. of German Machine Builders in 1907. Compilation of results is given in tables showing extent of employment, importance of export, development of prices, operating efficiency, etc., since 1909.

MAGNETS

Steels for. Steels for Permanent Magnets. Elecn. vol. 86, no. 2235, Mar. 18, 1921, pp. 327, 3 figs. Graphs showing magnetic qualities of hecla M. T. steel, Hadfield Research Laboratory, England.

MALLEABLE CASTINGS

Automotive Industry. Malleable Castings Production as Related to the Automotive Industry. Automotive Industries, vol. 44, no. 13, Mar. 31, 1921, pp. 708–711, 1 fig. Technical and commercial development of malleable castings production.

Influence of Manganese on Strength. Influence of Manganese on the Tensile Strength Properties of Malleable Castings (Einfluss des Mangans auf die Festigkeitseigenschaften des schmiedbaren Gusses), E. Leuenberger. Stahl u. Eisen, vol. 41, no. 9, Mar. 3, 1921, pp. 285–287, 3 figs. Results of tests show that with regard to these properties a higher manganese content than 0.4 per cent is permissible the tensile strength increases with increasing manganese content; up to about 1 per cent, manganese has no influence on expansion; etc.

Steel vs. Malleable Castings vs. Grey Iron and Steel. Enrique Touceda. Can. Foundryman, vol. 12, no. 4, April 1921, pp. 26–28, 4 figs. Ability to stand abuse, static and dynamic strength, ease of machining, smoothness of surface. Properties and limitations of malleable-iron castings.

MALLEABLE IRON

Annealing. Anneals Malleable Iron with Oil Fuel. William F. Hoernke. Foundry, vol. 49, no. 8, April 15, 1921, pp. 323–325, 3 figs. Experience of Stowell Co., Milwaukee. Oil is more expensive fuel but requires less labor in handling and firing.

Properties. American Malleable Cast Iron, H. A. Schwartz. Iron Trade Rev., vol. 68, nos. 13 and 15, Mar. 31 and April 14, 1921, pp. 901–904, 8 figs. and 1039–1042, 5 figs. Series of articles dealing with development of industry, modern methods of manufacture, metallurgical principles involved and properties of American malleable iron. Thermal and electrical properties of malleable iron.

MARINE BOILERS

Standard Construction. Standard Conditions for the Design and Construction of Marine Boilers. Steamship, vol. 32, no. 382, April 1921, pp. 239–242. Regulations issued by British Board of Trade. (To be continued.)

MARINE STEAM TURBINES

Reversing. A Description of a New Reversing Turbine. Mar. Eng., vol. 11, no. 1, Jan. 1921, pp. 40–42, 2 figs. Device to regulate steam supply automatically.

METALS

Calorizing. Protecting Metals Against Heat by Calorizing, Arthur V. Farr. Raw Material, vol. 4, no. 3, Mar. 1921, pp. 86–89, 6 figs. Process of calorizing consists in placing material in retort and heating in reducing atmosphere, retort being filled with mixture containing finely divided aluminum. Homogeneous aluminum alloy is formed for certain depth.

Fatigue of. Tests Support Theory of Fatigue, H. F. Moore. Iron Trade Rev., vol. 68, no. 13, Mar. 31, 1921, pp. 895–897, 3 figs. Experiments conducted on metals which were subjected to alternate and repeated strains showed that failure from fatigue is due largely to growth of minute flaws.

Properties. Physical Properties of Materials. U. S. Dept. of Commerce, Circular of Bur. of Standards, no. 101, Feb. 9, 1921, 52 pp. Strengths and related properties of metals and other engineering materials. Revision of Smithsonian physical tables.

METRIC SYSTEM

Compulsory Adoption in Japan. The Compulsory Adoption of the Metric System in the Japanese Empire (L'adoption obligatorre du système métrique par l'empire du Japan), Ch.-Ed. Guillaume. Comptes rendus des Séances de l'Académie des Sciences, vol. 172, no. 13, Mar. 29, 1921, pp. 795–796. Comment on significance of recent sanction by Japanese parliament of law making compulsory the use of the metric system in the Japanese empire.

MILLING

Gang Milling. Gang Milling. Eng. Production, vol. 2, no. 24, Mar. 17, 1921, pp. 342–345, 14 figs. Notes on cutters employed and their arrangement.

MILLING CUTTERS

Teeth, Spacing of. Metal Cutting Tools—VIII, A. L. DeLeeuw. Am. Mach., vol. 54, no. 15, April 14, 1921, pp. 635–640, 16 figs. Spacing of teeth of milling cutters.

MILLING MACHINES

Automatic. A New Automatic Miller. Eng. Production, vol. 2, no. 24, Mar. 17, 1921, pp. 340–341, 5 figs. Machines intended for manufacture of duplicating parts in large quantities. Spindle and table are controlled automatically. Manufactured by Buck and Hickman, London.

Continuous. Continuous milling J. H. Moore. Can. Machy., vol. 25, no. 14, April 7 1921, pp. 65–68, 9 figs. Rotary and reciprocating types of continuous milling machines.

High-Power. Rockford Milling Machine. Iron Age, vol. 107, no. 16, April 21, 1921, pp. 1039–1040, 2 figs. High-power, all-geared, single-pulley milling machine recently brought out by Rockford Milling Machine Co., Rockford, Ill. Rectangular overarm moved by rack and pinion. Single control for feed and quick return.

Rockford No. 3 "High-Power" Milling Machine, J. V. Hunter. Am. Mach., vol. 54, no. 14, April 7, 1921, pp. 585–587, 5 figs.

MOLYBDENUM

Norway. The Molybdenum Mines of Norway (Norske molybdengruber), Otto Falkenberg. Teknisk Ukeblad, vol. 68, no. 1, Jan. 7, 1921, pp. 6–11, 15 figs. Occurrences and properties of molybdenum. Norway has only specular molybdenum ore. Notes on production and treatment mainly in Elmore apparatus. It is used in chemical industry, but chiefly with alloyed steels. Prospects.

MOTION-PICTURE PHOTOGRAPHY

200,000 Photographs per Minute. Two Hundred Thousand Photographs per Minute, C. H. Claudy. Sci. Am., vol. 124, no. 15, April 9, 1921, pp. 288–297 and 299, 6 figs. High-speed motion-picture projectors and camera which makes use of prisms instead of usual shutter and intermittent movement mechanism.

MOTOR PLOWS

Tests. Factors Influencing the Draft of Plows, E. V. Collins. Agricultural Eng., vol. 2, no. 2, Feb. 1921, pp. 27–29, 7 figs. Records of tests.

MOTOR-TRUCK TRAFFIC

Legislation. How Maryland Enforces Its Motor Vehicle Law. Eng. News-Rec., vol. 86, no. 16, April 21, 1921, pp. 666–668, 3 figs. Truck weights checked by scales and loadometers. Ten tons limit. Excess loads deposited at roadsides.

Refrigerated Transport. Road Traction for Refrigerated Transport, H. M. Dunkerley. Cold Storage & Ice Assn., vol. 17, no. 1, 1920–1921, pp. 25–36 and (discussion) pp. 37–47, 3 figs. on 2 supp. plates. Requirements of vehicles used in transporting refrigerated product.

MOTOR TRUCKS

Maintenance. The Care and Maintenance of Motor Trucks, N. J. Smith. Jl. Soc. Automotive Engrs., vol. 8, no. 4, April 1921, pp. 331–334. Practice of Consumers Co., which operates 159 motor trucks for delivering coal, ice and other supplies in territory covering city of Chicago and outlying districts.

Trailers. How to Apply Trucks and Trailers Under Given Load and Road Conditions, Marius C. Krarup. Automotive Industries, vol. 44, no. 12, Mar. 24, 1921, pp. 654–658, 5 figs. Table giving drawbar pull obtainable at speeds from 1 to 20 m.p.h. from net horsepower available at rims of driving wheels. Graph of resistances to vehicle movements due to grades and irregular or soft road surfaces.

MOTORSHIPS

Two-Cycle vs. Four-Cycle Engines. Two Versus Four Cycle Diesel Engines. Mar. Eng., vol. 26, no. 4, April 1921, pp. 321–323, 2 figs. Competition between manufacturers of two types in Europe.

N

NICKEL

Electrolytic. Ductile Electrolytic Nickel, Chas. P. Madsen. Thirty-Ninth Gen. Meeting, Am. Electrochemical Soc., April 21–23, 1921, advance paper no. 23, pp. 269–276. Experiments confirming writer's discovery that if cathodes in nickel electrolytic bath are periodically lifted out of bath, exposed to air, and reimmersed within certain limiting time, nickel deposit does not laminate but is greatly improved as regards freedom from pitting and mechanical properties.

The Use of Fluorides in Solutions for Nickel Deposition, William Blum. Thirty-Ninth Gen. Meeting, Am. Electrochemical Soc., April 21–23, 1921, advance paper no. 21, pp. 227–247, 3 figs. Discusses factors governing deposition of hard deposits of nickel from solutions containing fluorides, with and without boric acid and other salts. General principles of getting good deposits are discussed, showing that low acidity favors good nickel deposition, but high acidity good anode corrosion. Bearing of hydrogen-ion concentration on matter is explained.

NICKEL ALLOYS

Compositions, Properties, Uses. Miscellaneous Alloys of Nickel, Paul D. Merica. Chem. & Metallurgical Eng., vol. 24, no. 15, April 13, 1921, pp. 649–653. Principal data on binary alloy systems with nickel as one constituent. Use of nickel in bronzes and light aluminum alloys. Composition and electrical characteristics of many special resistance alloys. Analyses of complex alloys for various minor uses.

OFFICE BUILDINGS

Reinforced-concrete. Construction Detail of General Motors Office Building, Joseph Matte, Jr. Eng. Newe-Rec., vol. 36, no. 15, April 14, 1921, pp. 625–630, 12 figs. Fifteen-story structure with thirty-two acres of floor space to house 6000 persons. Heavy girders and columns in steel frame. Reinforced-concrete laborator building.

OIL ENGINES

Densil. A Serviceable Crude-Oil Engine. Steamship, vol. 32, no. 382, April 1921, pp. 251–253. Densil single-cylinder engine of hot-bulb type, with additional water-cooled head distinct from cylinder and bulb.

Marine. Reversing of Marine Oil Engines, Walter Pollock. Trans. Inst. Mar. Engrs., vol. 32, Feb. 1921, pp. 347–380, 10 figs. Classification and description of reversing systems in use.

OIL FIELDS

Argentina. The Petroliferous Region of Cacheuta (La región petrolífera de Cacheuta), Guillermo Hileman. Ingeniería Internacional, vol. 5, no. 5, May 1921, pp. 286–289, 3 figs. Geological description of and account of prospecting operations in Argentina region.

Australia. The Possibility of Oil Discovery on the Mainland of Australia, Wm. Clarkson. Petroleum Times, vol. 5, no. 114, Mar. 12, 1921, pp. 309–311. Conditions essential to occurrence of oil in quantity. Prospecting experiences in Australia.

Borneo. The Crude Oils of Borneo, James Kelway. Petroleum Times, vol. 5, no. 115, Mar. 19, 1921, pp. 335–339. Geological and chemical notes.

Canada. Oil Possibilities of the Mackenzie—A Warning. Eng. & Min. Jl., vol. 111, no. 13, Mar. 26, 1921, pp. 553–554. It is said oil dissipation has taken place and transportation is a serious problem.

OIL FUEL

Burners. Oil Fuel Burners Insuring Complete Preliminary Combustion of Liquid (Brûleur à combustion complete préalable, pour combustibles liquides). Génie Civil, vol. 78, no. 13, Mar. 26, 1921, p. 279, 1 fig. Air and pulverized fuel are thoroughly mixed and ignited in special chamber before passing into furnace proper.

Flue-Gas Analyses with. Records of Flue Gas Analyses with Fuel Oil, L. J. Goodrich. Power Plant Eng., vol. 25, no. 7, April 1, 1921, pp. 366–367, 2 figs. Calculation of fuel losses from flue-gas analyses and moisture contents of fuel and air.

Stowing on Board Ship. Hydraulic System for Stowing and Handling Fuel Oil on Board Ships in Yards or Docks. Mar. Eng., vol. 26, no. 4, April 1921, pp. 304–305, 1 fig. Adaptation of hydraulic system for control of oil fuel of large dredge.

Uses. Fuel Oil, W. A. White. Trans. North-East Coast Instn. Engrs. & Shipbuilders, vol. 37, part 4, Feb. 1921, pp. 209–238, 4 figs. Estimated petroleum deposits of the world. Statistics of production and transport of oil fuel. Typical oil-fuel storage station. Uses of oil fuel.

Uses of Oil Fuel (Emploi des combustibles liquides, M. Pillard. Arts et Métiers, vol. 74, no. 4, Jan. 1921, pp. 3–9, 4 figs. Tests on use of oil fuel in industrial furnaces.

OIL INDUSTRY

Canada. Canada a Vast Storehouse of Oil Resources, Earle W. Gage. Gas Engine, vol. 23, no. 4, April 1921, pp. 85–87. Canada's annual oil production, according to government statistics, amounts to nearly 319,000 bbl. 90 per cent from Ontario fields.

Poland. Petroleum Industry in Poland. Min. & Oil Bul., vol. 7, no. 4, Mar. 1921, pp. 219–221, 4 figs. Output of fields has reached level of about 842,000 barrels a month.

United States. America's Petroleum Problem, J. O. Lewis. Jl. Franklin Inst., vol. 191, no. 3, Mar. 1921, pp. 357–379. Probable duration of oil supply in U. S. taking into account continuously increasing rate of consumption of oil. No exhaustion for many generations is apprehended.

OIL SHALES

Colorado. Studies in Colorado Shale Oils, Arthur J. Franks. Chem. & Metallurgical Eng., vol. 24, no. 13, Mar. 30, 1921, pp. 561–564, 2 figs. Lighter hydrocarbon oil fractions found to be more saturated than heavier fractions. Methods used in obtaining data. Graphical analysis of distillation cuts, showing temperatures, saturation and specific gravities.

Scotland. The Necessity for Research in the Oil-Shale Industry, Martin J. Gavin. Sci. & Industry, vol. 2, no. 12, Dec. 1920, pp. 746–760, 4 figs. Account of shale-oil industry as developed in Scotland. Steam-regulated pyrolytic distillation. Quality and quantity of oil yields.

OPEN-HEARTH FURNACES

Controlling Valve. New Controlling Valve for Open Hearths, W. H. Wharton. Blast Furnace & Steel Plant, vol. 9, no. 4, April 1921, pp. 253 and 289, 1 fig. Reversing valve combined with air-pressure and volume-controlling mechanism.

Fluorspar Addition. The Use of Fluorspar in Open-Hearth Furnaces (Ueber die Verwendung von Flussspat in Martinöfen), S. Schleicher. Stahl u. Eisen, vol. 41, no. 11, Mar. 17, 1921, pp. 357–361 and (Discussion) pp. 362–364, 2 figs. It is pointed out that if fluorspar is added to an open-hearth slag it decomposes only to a certain extent; fluorspar has a desulphurizing effect in that the sulphur is volatilized from the slag in any desired form so that the slag can re-absorb sulphur from the bath.

OXY-ACETYLENE WELDING

Plate-Steel Roof. Oxy-Acetylene Welding and Cutting at Anaconda, Thomas W. Cunningham. Min. & Sci. Press, vol. 122, no. 13, Mar. 26, 1921, pp. 425–426. Welding of plate-steel roof of metallurgical mill.

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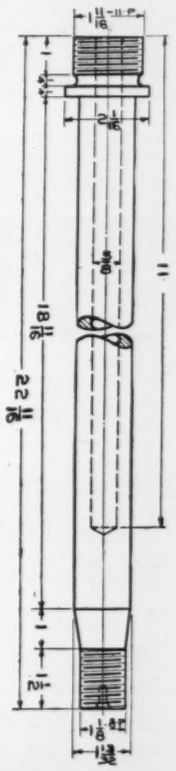

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ENGINEERING INDEX (Continued)

Pressure Vessels. Oxy-Acetylene Welding and Cutting, P. E. Willis. Jl. Engrs. Club of St. Louis, vol. 6, no. 1, Jan.-Feb.-Mar. 1921, pp. 13–28. Uses of oxy-acetylene welding torch. Its application to welding of pressure vessels.

P

PAPER MANUFACTURE

Size Standardization. Standardization of Sizes in the Manufacture of Paper. Paper, vol. 27, no. 27, Mar. 16, 1921, pp. 9–10 and 36. List of proposed standards.

PEAT

Minnesota. Experimental Work on Minnesota Peat Soils, F. J. Alway. Jl. Am. Peat Soc., vol. 14, no. 2, April 1921, pp. 40–47, 2 figs.

Utilization. The Manufacture and Utilization of Peat Fuel, Benj. F. Haanel. Jl. Am. Peat Soc., vol. 14, no. 2, April 1921, pp. 1–25, 3 figs. Curve showing effect on calorific power of wet peat by removing different percentages of total moisture content. Investigation on rate at which drying takes place during operating period. Paper read before Am. Inst. Chem. Engrs.

PIERS

Concrete. Oil Protects Concrete Piers from Sea Water Action, Contract Rec., vol. 35, no. 11, Mar. 16, 1921, pp. 268–272, 8 figs. Examination of test specimens immersed since 1909 shows them covered with tar-like coating which prevents corrosion. Rich wet mixes seem least affected by salt water.

PIG IRON

Manufacture. Foundry Pig Iron in Birmingham District, Y. A. Dyer. Iron Age, vol. 107, no. 14, April 7, 1921, pp. 907–909, 3 figs. Trend towards use of machine-cast pig by foundries. Claimed advantages over sand-cast iron include lower melting point.

PILES, CONCRETE

Sea Water, Action of. The Action of Sea Water on Concrete Piles. Contract Rec., vol. 35, no. 12, Mar. 23, 1921, pp. 288–291, 6 figs. Analysis of tests carried out by Aberthaw Construction Co. during past twelve years.

PIPE BENDS

Soft Steel. Pipe Bends (Rohrbogen). Autogene Metallbearbeitung, vol. 14, no. 4, Feb. 15, 1921, pp. 54–59, 26 figs. Describes low-carbon-steel pipe bends manufactured according to a patented process in different curve radii of one-quarter to three-quarter arc and representing finished manufactured articles produced by the Pipe Bend Works, Ltd., Hamburg.

PIPE CONCRETE

Tests. Test Concrete Pressure Pipe With Encased Steel Diaphragm. Eng. News-Rec., vol. 86, no. 15, April 14, 1921, pp. 645–646, 3 figs. Inside of reinforced-concrete shell is 3/16-in. steel pipe which is welded at joints between cast sections.

PIPE, IRON

Strength. Collapsing Strength of Iron Pipes and Tubes, W. F. Schaphorst. Power Plant Eng., vol. 25, no. 8, April 15, 1921, pp. 431. Chart for determining collapsing of iron pipes.

PIPE, STEEL

Spellerized. Spellerized Steel Piping. Power, vol. 53, no. 13, Mar. 29, 1921, pp. 513, 1 fig. Spellerizing process consists of passing heated bloom through rolls and reducing it to proper dimensions for finished product. Spellerizing rolls have regularly shaped projections on their working surface.

PIPE, WROUGHT IRON

Manufacture. Manufacture of Wrought Pipe for High Pressures. Machy. (N. Y.), vol. 27, no. 8, April 1921, pp. 755–756, 5 figs. Practice of National Tube Co., Pittsburgh.

PLANING

Production Systems. Production Planing in Machine Tool Plants. Machy. (Lond.), vol. 17, nos. 442 and 444, Mar. 17 and 31, 1921, pp. 747–752, 8 figs., and 793–797, 7 figs. Methods used in shops of representative planer and engine-lathe builders.

Production Planing in Machine Tool Plants—V. Machy. (Lond.), vol. 17, no. 444, Mar. 31, 1921, pp. 793–797, 7 figs. Methods used in planer-building shops.

PLATES

Stresses in. Contact Pressures and Stresses, E.G. Coker, K. C. Chakko and M. S. Ahmed. Engineering, vol. 111, no. 2882, Mar. 25, 1921, pp. 373–376, 10 figs. Analytical study of stress distribution in plate around point at which concentrated load is applied. Experimental confirmation of analytical results. (To be continued.) Paper read before Instn. Mech. Engrs.

PRESSES

Industrial. Penkala Presses for Compression of Materials and Extraction of Liquids Therefrom (Presses système Penkala, pour l'agglomération des matières et pour l'extraction des liquides qui y sont contenus), M. Biver. Génie Civil, vol. 78, no. 13, Mar. 26, 1921, pp. 265–267, 4 figs. Types of industrial presses, particularly presses used for extraction of juice from cane sugar.

PROPELLERS, SHIP

Design. The Evolution of a New Type of Propeller, H. W. Gill. Mar. Eng., vol. 11, no. 1, Jan. 1921, pp. 17–22, 9 figs. Four-bladed vortex-type propeller protected by outside rim.

Tests. The Screw Propeller—II. Supplément au bulletin technique du Bureau Veritas, Mar. 1921, pp. 9–16, 4 figs. Results of experiments on model propellers with elliptical blades and with wide, deep blades.

Thacher Molding Process. Thacher Molding Process for Propeller Wheels and Blades, Enrique Touceda. Trans. Am. Inst. Min. & Metallurgical Engrs., advance paper, 12 pp. 9 figs. Method developed by Geo. H. Thacher & Co., Albany, N. Y., for rapid manufacture of marine and other gray-iron castings. No subsequent machining is required on blades of propellers.

PROTECTIVE COATINGS

Metal Paints. Metal Protective Paints, Henry A. Gardner. Thirty-Ninth Gen. Meeting, Am. Electrochemical Soc., April 21–23, 1921, advance paper no. 11, pp. 85–87. Chemical classification of substances used as paints on metallic structures.

PULVERIZED COAL

Gasification. Gasification of Powdered Coal, A. E. Bourcoud. Chem. & Metallurgical Eng., vol. 24, no. 14, April 6, 1921, pp. 600–604, 4 figs. Consideration of velocity with which reaction takes place between producer gas and suspended carbon, using results for estimating proposal for gasifying powdered coal or oil.

Systems of Burning. Powdered Fuel, Robert James. Proc. So. Wales Inst. Engrs., vol. 37, no. 1, Mar. 10, 1921, pp. 73–110, 18 figs. Systems of burning pulverized coal. Use of pulverized coal in boiler furnaces, locomotives, marine boilers, etc.

Uses. Metallurgical Use of Pulverized Fuel, C. F. Herington. Iron Age, vol. 107, no. 15, April 14, 1921, pp. 965–969, 4 figs. Advances made in utilization of powdered coal as fuel in metallurgical furnaces. List of plants and equipment. There are approximately 2000 metallurgical furnaces using pulverized coal. Plants listed are principally in U. S. and Canada.

PUMPS

Air-Lift. Air-Lift Pumps—Information Required for Design, R. M. Anderson. Stevens Indicator, vol. 37, no. 4, Oct. 1920, pp. 249–269, 10 figs. Formulas, graphs and tables.

PYROMETERS

Platinum-Resistance. Recent Modifications in the Construction of Platinum Resistance Thermometers, T. S. Sligh, Jr., Dept. of Commerce, Sci. Papers, Bur. of Standards, no. 407, Jan. 5, 1921, pp. 49–63, 2 figs. Survey of developments in construction of resistance thermometers as regards heads, leads, terminals and sealing of strain-free type. Elimination of drying head and use of all-metal case with calorimetric type of resistance thermometer.

R

RAILS

Creeping. Rail Creep. Ry. Gaz., vol. 34, no. 11, Mar. 18, 1921, pp. 430–432, 4 figs. Analysis of causes and effects of rail creeping and description of anti-creep anchors.

French Standard. Standard Rails and Splice Bars on French Railways. Eng. News-Rec., vol. 86, no. 11, Mar. 17, 1921, p. 473, 1 fig. Standard rails recommended by commission of engineers appointed at conference between French minister of war and heads of railway systems. Translated from Revue générale des Chemins de Fer.

RAILWAY ELECTRIFICATION

Austria. The Electrification of the Arlberg Railway (Die Elektrifizierung der Arlbergbahn), A. Marschall. Elektrotechnische Rundschau, vol. 38, no. 3, Feb. 7, 1921, pp. 15–16. Notes on the Spuller Lake power station under construction which is the largest railway power station in new Austria and technically one of the most important plants in Europe. Details of equipment and construction.

Economic Advantages. Electrification Reviewed from the Standpoint of Service. C. C. Whittaker. Ry. Rev., vol. 68, no. 13, Mar. 26, 1921, pp. 483–487, 4 figs. Operating advantages resulting from substitution of electricity for steam in railway service. Paper presented before Providence Eng. Soc.

The Economic Aspects of Railway Electrification A. H. Armstrong. Jl. Franklin Inst., vol. 191, no. 4, April 1921, pp. 493–502. Economic advantages of railway electrification, principally from aspect of future growth of transportation system of country and its effect upon national transportation.

France. French Railways Electrification. Elec. Ry. & Tramway Jl., vols. 43 & 44, nos. 1055, 1060, 1064 and 1068, Dec. 10, 1920, Jan. 14, Feb. 11, Mar. 11, 1921, pp. 280–282, 17–19, 61 and 105–107. Official report issued by Ministère des Travaux Publics, containing full details of proceedings of Comité d'Études for electrification of systems of great railways as well as various decisions which have been arrived at in respect of lines to be electrified, sources of hydro-electric power, systems of generation and distribution, volatge and frequency, methods of current collection, types of electric locomotives, costs of establishment and operation, and other cognate matters.

India. The Electrification of Indian Railways—III. Ry. Engr., vol. 42, no. 494, Mar. 1921, pp. 92–97, 15 figs. Advantage of using electric locomotives as compared with steam locomotives on heavily graded sections of North Western Ry. of India.

RAILWAY REPAIR SHOPS

Machining Locomotive Parts. Railway Machine Shop Practice—I, Edward K. Hammond. Machy. (N. Y.) vol. 27, no. 8, April 1921, pp. 721–729, 17 figs. Methods employed in railway repair shops for machining locomotive parts.

RAILWAY SHOPS

Sheet-Metal Work. Sheet-Metal Shop Equipment for Railroad Work, J. V. Hunter. Am. Mach., vol. 54, no. 16, April 21, 1921, pp. 683–686, 11 figs. Typical modern power shears, presses and brakes.

RAILWAY SIGNALING

Interlocking. A New Idea in Traffic Locking on the C. & O., H. E. Johnson. Ry. Signal Engr., vol. 14, no. 4, April 1921, pp. 129–131, 7 figs. Traffic-locking scheme developed in order to increase track capacity on congested portions of road.

Non-Interlocking. Non-Interlocking Non-Stop Grade Crossings, L. B. Porter. Ry. Signal Engr., vol. 14, no. 4, April 1921, pp. 144–147, 3 figs. Proposed signal layout to control train movements automatically at intersection points to prevent train stops.

RAILWAY TIES

Steel. Steel Sleepers on the North Eastern Railway. Ry. Gaz., vol. 34, no. 12, Mar. 25, 1921, p. 476, 3 figs. Trial of steel ties under main-line traffic conditions.

RAILWAY TRACK

Buffer Stops. Hydraulic Buffer Stops. Practical Engr., vol. 63, no. 1780, April 7, 1921, pp. 214–216, 4 figs. Buffers suitable for trains weighing up to 500 tons approaching at speed of 10 miles per hour. Stroke of buffer is 8 ft.

RAILWAYS

Light. On the Question of Safety Appliances on Light Railways. Subject XX for Discussion at the Ninth Congress of the International Railway Association, Serge de Kareischa. Bul. Int. Ry. Assn., vol. 3, no. 3, Mar. 1921, pp. 247–304. Report based on answers received from 63 railways in different countries, operating 75 lines.

Pan-American. Intercontinental Pan-American Railway (Ferocarril International Pan-Americano), Juan A. Briano. Ingeniería, vol. 24, no. 5, Feb. 1, 1920, pp. 99–103. Advocates construction of Peruvian railways with a view to facilitate establishment of Pan-American intercontinental railway. (To be continued.)

REDUCTION GEARS

Double. Mechanical Gears, of Double Reduction, for Merchant Ships, R. J. Walker and S. S. Cook. Engineering, vol. 111, no. 2882, Mar. 25, 1921, pp. 369–370, 3 figs. Graphs showing torque variation at gear wheel end of propeller shaft determined in experiments on S. S. San Fernando. Paper read before Instn. Naval Architects.

REFRIGERATING MACHINES

Ethyl Chloride. The Ethyl Chloride Refrigerating Machine, Charles Bishop. Cold Storage & Ice Assn., vol. 17, no. 1, 1920–1921, pp. 51–63 and (discussion) pp. 64–71, 4 figs. on 4 supp. plates. Installation of Clothel system in Canadian ships.

RESEARCH

Industrial. The Coöperation of Scientific and Industrial Research in the Iron Foundry, Thos. Vickers. Foundry Trade Jl., vol. 23, no. 241, Mar. 31, 1921, pp. 288–290. Economic advantage of cooperation. (To be continued.) Paper read before Instn. British Foundrymen.

Industrial, Belgium. Organization of Scientific and Industrial Research in Belgium (Organisation de la recherche scientifique et industrielle en Belgique), Edgar Forgeur. Revue universelle des Mines, vol. 8, no. 6, Mar. 15, 1921, pp. 501–522, 1 fig. Suggested scheme for national organization under Central Board of Control.

Scientific. Promotion of Scientific Research, William Hoskins and Russell Wiles. Chem. & Metallurgical Eng., vol. 24, no. 16, April 20, 1921, pp. 689–691. Outline of program for forwarding research in chemical and physical sciences at universities. Industries licensed under patentable discoveries to pay reasonable royalties for support of further research.

ROADS

Subgrades. Investigations of Road Subgrades, A. T. Goldbeck. Jl. Soc. Automotive Engrs., vol. 8, no. 4, April 1921, pp. 339–346, 7 figs. Tests being conducted by Bur. of Public Roads.

ROLLING MILLS

Mannesmann Process. Mannesmann Process Rolling Machinery. Carl Gruber. Iron Age, vol. 107, no. 16, April 21, 1921, pp. 1049–1052, 13 figs. Design of rolling mill and its machinery. Details of adjustment devices and guides and of mandrel. (To be continued.) (Abstract.) Translated from Stahl und Eisen.

Sheet Mills. Drive is Feature of Sheet Mill, John D. Knox. Iron Trade Rev., vol. 68, no. 16, April 21, 1921, pp. 1099–1105 and 1111, 20 figs. Roughing rolls driven by friction gears at plant of Superior Sheet Steel Co., Canton, O. High-speed motors with automatic control are provided. Individual squaring shears serve each hot mill.

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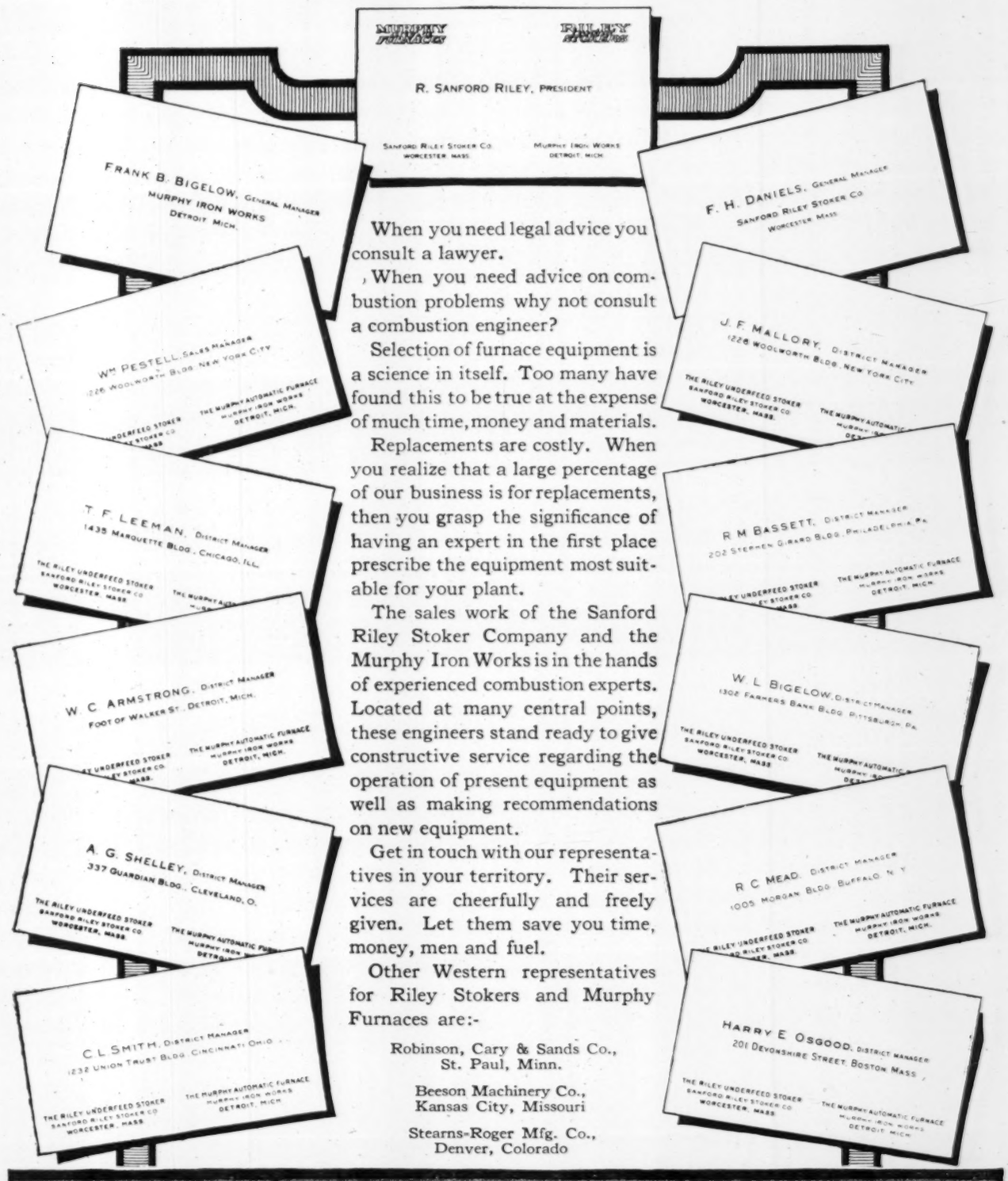
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ENGINEERING INDEX (Continued)

St. Louis. Scullin Steel Company's New Mills, F. B. Menner. Blast Furnace & Steel Plant, vol. 9, no. 4, April 1921, pp. 260–261. Installation designed to produce wide range of billets, merchant bars and structural shapes.

RUDDERS

Design. The Design of Balanced Rudders of the Spade Type, M. E. Denny. Engineering, vol. 111, no. 2882, Mar. 25, 1921, pp. 370–373, 5 figs. Formulas for determining diameter of stock required to deal with bending and twisting moments and power of steering engine adequate to operate rudder, and determination of longitudinal position of stock relative to rudder area. Paper read before Instn. Naval Architects.

S

SAWS

Circular. A New Cold Circular Saw Machine (Eine neue Kaltkreissägemaschine), Eduard Müller. Betrieb (special no.), vol. 3, no. 11, Mar., 1921, pp. 316–319, 9 figs. "Guwa" cold circular saw manufactured by the Gustav Wagner Machine Factory, Reutlingen, Germany, which is said to combine increased efficiency with diminished consumption of power; it operates with four cutting speeds and twelve cutting widths.

SCIENTIFIC MANAGEMENT

See INDUSTRIAL MANAGEMENT.

SCREW MACHINES

Automatic. Magazine Feeds for Automatic Screw Machines. Machy. (Lond.), vol. 18, no. 443, Mar. 24, 1921, pp. 757–762, 10 figs. Special equipments developed by Cleveland Automatic Machine Co., for handling second-operation work.

Producing 900 Float Valve Seats Every Hour, J. H. Moore. Can. Machy., vol. 25, no. 15, April 14, 1921, pp. 25–28, 8 figs. Automatic procedure in making spark plug shells, carburetor float valve seats, piston wrist pins, transmission bolts, sewing machine screws, cylinder priming bodies and nuts in quantity.

SCREW THREADS

National Screw Thread Commission. Progress Report of the National Screw Thread Commission. Dept. of Commerce, Bur. of Standards, no. 42, Jan. 4, 1921, 109, pp. 44 figs. National Screw Thread Commission was created by Act of Congress approved July 18, 1918, for the purpose of ascertaining and establishing standards for screw threads for use of the various branches of the Federal Government and for the use of manufacturers. Report recommends certain systems of threads, and gives information, data and specifications pertaining to manufacture of threads recommended.

SEMI-DIESEL ENGINES

Beardmore. The Beardmore Semi-Diesel Oil Engine. Mar. Eng., vol. 11, no. 3, Mar. 1921, pp. 17–20, 16 figs. Four-cylinder unit manufactured by William Beardmore & Co., Glasgow. Ignition is effected by hot bulb.

Tuxham. The Semi-Diesel Engine (Le moteur semi-Diesel). Revue de l'Ingénieur, vol. 28, no. 2, Feb. 1921, pp. 69–77, 4 figs. Description of Tuxham motor built at Delaunay-Belleville works.

SHAFTS

Standardization. Standard Shaft versus Standard Hole (Einheitswelle oder Einheitsbohrung?). Betrieb, vol. 3, no. 13, Mar. 25, 1921, pp. 181–184. Report of sub-committee before the working committee for allowances of the German Industry Committee on Standards (NDI).

Stresses in. Graphical Method of Computing Stresses in Shafts of Electric Machines Rotating Between Three Bearings (Complément aux méthodes graphiques de calcul des flèches arbres des machines électriques à trois paliers), P. Durand. Revue générale de l'Électricité, vol. 9, no. 11, Mar. 12, 1921, pp. 369–370, 7 figs. Formulas for computing stresses in vertical shaft.

Tests. Torsion and Torsion Tests of Shafts, Arthur G. Robson. Practical Engr., vol. 63, no. 1779, Mar. 31, 1921, pp. 196–198, 2 figs. Interpretation of results of tests.

SHEARING MACHINES

Plate. The Modern Methods of Shearing Plates. (Neuzeitliche Blechbearbeitung), H. Graichen. Betrieb, (special no.), vol. 3, no. 11, Mar., 1921, pp. 313–316, 6 figs. Describes a number of plate-shearing machines and summarizes requirements which such machines must fulfill.

Rotary. Rotary Shearing Machines. Engineering, vol. 111, no. 2882, Mar. 25, 1921, p. 353, 4 figs. Machines constructed by Tangent Tool Co., Somerset, England.

SHIP DESIGN

Speed, Depth of Water and. The Influence of the Depth of Water on the Speed of Ships. Engr., vol. 131, nos. 3404 and 3405, Mar. 25, and April 1, 1921, pp. 309–311, 2 figs, and 340–342, 4 figs. Records of experiments conducted by British Admiralty. Survey of literature. Calculations.

SHIP PROPULSION, ELECTRIC

U. S. S. Tennessee. Propelling Machinery of the U. S. S. Tennessee. Mar. Eng., vol. 26, no. 4, April 1921, pp. 269–273, 7 figs. Latest American battleship driven by electricity generated in Westinghouse turbine generators delivering 40,000 hp.

SHIP SALVAGING

Italian Battleship. The Salving of the Italian Battleship Leonardo da Vinci. Engr., vol. 131, no. 3403, Mar. 18, 1921, pp. 281–283, 16 figs. partly on supp. plate. As result of explosion battleship sank in six fathoms of water. Holes in sides were patched and large number of compartments in ship were rendered airtight under water. Battleship has overall length of 650 ft. and displacement of 22,280 tons.

SHIPBUILDING

Manufacturing Methods. Methods in a Shipbuilding Plant, Fred H. Colvin. Am. Mach., vol. 54, no. 16, April 21, 1921, pp. 672–676, 14 figs. Special machines used by Union Iron Works Plant of Bethlehem Shipbuilding Co., together with work-holding fixtures and labor-saving appliances.

Systems of Construction. A Study of the Framing of a Ship, T. B. Abell. Engineering, vol. 111, no. 2882, Mar. 25, 1921, pp. 376–378, 7 figs. Suggested system of construction. Pillars at middle line or two rows of closel spaced pillars. Paper read before Instn. Naval Architects.

SHIPS

Welded. An Entirely Electrically Welded Vessel. Mar. Eng., vol. 26, no. 4, April 1921, p. 277, 1 fig. Vessel was completed at works of Elektriska Svetsnings Aktiebolaget, Gothenburg, Marieholm, Sweden. Dimensions: Length, 52 ft. 6 in.; breadth, 13 ft. 1 in.; depth molded, 7 ft.; draft, 3 ft. 6 in.

SHIPS, CONCRETE

Construction. Lossier System of Constructing Sea-Going Reinforced-Concrete Vessels at Dufour Shipyard, Paris (Les chalands de mer en béton armé système Henry Lossier, construits aux chantiers Dufour, à Harfleur), Robert Sauser. Génie Civil, vol. 78, no. 11, Mar. 12, 1921, pp. 225–230, 15 figs. Characteristics: Length between perpendiculars, 50 meters; width, 10.65 meters; draft, 6.40 meters; displacement, 1000 tons.

SHOP COMMITTEES

Whitley Councils. The Functions of a Work's Council. Eng. & Indus. Management, vol. 5, no. 14, April 7, 1921, pp. 405–408. Scheme in operation at factory of Cadbury Bros., Birmingham, England.

SLIDE RULES

Vector Type. The Vector Slide-Rule, A. F. Zahn. Jl. Franklin Inst., vol. 191, no. 4, April 1921, pp. 525–528, 2 figs. Slide rule for finding magnitude and line resultant when its combination and its moment about a point are given.

SOOT BLOWERS

Tests. Development of Mechanical Soot Blowers, Robert June. Blast Furnace & Steel Plant, vol. 9, no. 4, April 1921, pp. 275–279, 6 figs. Tests of mechanical soot blowers with coal, pulverized fuel and oil.

Tests of Mechanical Soot Blowers, Robert June. Textile World, vol. 59, no. 14, April 2, 1921, pp. 111–115, 4 figs.

SPRINGS

Helical. Charts for the Calculation of Helical Springs (Tafeln zur Berechnung von zylindrischen Schraubenfedern), Adolf Maydell. Dinglers polytechnisches Jl., vol. 336, no. 3, Feb. 12, 1921, pp. 41–42, 2 figs.

Design of Helical Springs, Joseph Kaye Wood. Am. Mach., vol. 54, no. 15, April 14, 1921, pp. 628–632, 4 figs. Alignment chart for determining spring size.

STAMPING

Thin Steel Plates. Stamping Tests of Thin Steel Plates (Essai a l'emboutissage des tôles minces), Ch. Fremont. Bulletin de la Société d'Encouragement pour l'Industrie nationale, vol. 120, no. 3, Mar. 1921, pp. 241–253, 22 figs. Experimental study of relation between behavoir of steel plate in stamping press and mechanical properties. Steel plates were principally tested, also copper, brass and aluminum plates.

STANDARDIZATION

Austria. History and Activity of the Austrian Committee on Standards for Trade and Industry (ÖNIG) (Geschichte und Tätigkeit des österreichischen Normenausschusses für Industrie und Gewerbe), P. Bretschneider. Zeit. des Oesterr. Ingenieur-u. Architekten-Vereines, vol. 73, no. 13, Apr. 1, 1921, pp. 81–82. (Abstract.)

STAYBOLTS

Standardization of. Standardization of Boiler and Staybolt Taps. Ry. Jl., vol. 27, no. 4, April 1921, pp. 12–17, 7 figs. Suggestions and recommendations made by Committee of Am. Ry. Tool Foremen's Assn.

STEAM-ELECTRIC PLANTS

Chicago. The New Gulbransen-Dickinson Plant. Power Plant Eng., vol. 25, no. 8, April 15, 1921, pp. 401–405, 5 figs. Wood waste utilized as fuel in steam electric isolated plant of Chicago Player Piano Manufacturer.

Newcastle-on-Tyne. A Modern Power Station and Its Development, J. S. Watson, Trans. North-East Coast Instn. Engrs. & Shipbuilders, vol. 36, part 8, Oct. 1920, pp. 496–506 and (discussion) pp. 506–538, 2 figs. on supp. plate. Steam-electric station at Newcastle-on-Tyne with total capacity of 186,540 kw.

STEAM ENGINES

Governors. The "Bee" Governor. Practical Engr., vol. 63, no. 1775, Mar. 3, 1921, pp. 139–142, 5 figs. Patented direct-acting spring-loaded enclosed governor.

The Regulation of Slow-Speed Steam Engines by Means of Slipping Eccentrics (Regeling van een stoomwerktuig met verstelbaar excentriek bij een laag aantal omwentelingen), G. Brouwer. Ingenieur, vol. 36, no. 7, Feb. 12, 1921, pp. 126–131, 8 figs. It is shown that centrifugal governors are not adapatable to slow-speed engines, and an oil-pressure governor without centrifugal action is described which is said to be adaptable for such engines.

Rolling-Mill Drive. A Big Vertical Mill Engine. Engr., vol. 131, no. 3405, April 1, 1921, pp. 354–355, 9 figs. partly on 2 supp. plates. Three-cylinder rolling-mill engine capable of developing maximum of 25,000 hp. at 140 r.p.m. Cylinders are each 45 in. diameter by 42 in. stroke and all take steam at 190 lb. per sq. in., superheated 100 deg. fahr.

STEAM POWER PLANTS

Layout. Fundamental Principles for the Constructional Arrangement and Develpment of Power Plants (Grundzüge fur die bauliche Anordnung und Entwicklung von Kraftwerksanlagen), A. Ruster. Zeit. des Bayerischen Revisions-Vereins, vol. 25, nos. 4 and 5, Feb. 28 and Mar. 15, 1921, pp. 25–28 and 33–35, 8 figs. Deals with plants for generation of heat. Details of steam-boiler installations of modern power plants. (Abstract.)

STEAM TURBINES

Installation. New Turbine Plant of the Hudson Motor Car Co. Power, vol. 53, no. 15, April 12, 1921, pp. 572–575, 8 figs. Turbines of condensing and non-condensing types installed with flexible arrangement to supply varying quantities of exhaust steam.

[See also MARINE STEAM TURBINES]

STEEL

Alloy. See ALLOY STEELS.

Chromium. See CHROMIUM STEEL.

Copper, Influence of. Influence of Copper on Some Physical Properties of Iron and Steel, E. A. Richardson and L. T. Richardson. Chem. & Metallurgical Eng., vol. 24, no. 13, Mar. 30, 1921, pp. 565–567. Number of ferrous alloys were made and physical properties of forging, filing, grinding, chiseling and bending determined. It was found that copper caused iron to be red-short and that manganese or chromium removed this difficulty.

Corrosion-Resisting. Anomalies Encountered in a Study of Immersion Tests of Iron and Steel, Allerton S. Cushman and George W. Coggeshall. Thirty-Ninth Gen. Meeting, Am. Electrochemical Soc., April 21–23, 1921, advance paper no. 22, pp. 249–267, 3 figs. Plea for considering all possible factors when comparing corrosion tests of iron and steel, on ground that there are in reality so many and so obscure variables that it is very easy to draw wrong conclusions. Tests in aluminum sulphate solutions, giving curious colloidal gels, are described. Writer denies protective action of copper in steel.

Observations on the Corrosion of Iron and Steel, J. A. Aupperle and D. M. Strickland. Thirty-Ninth Gen. Meeting, Am. Electrochemical Soc., April 21–23, 1921, advance paper no. 17, pp. 167–177, 2 figs. Records of tests on pure iron made in open-hearth furnaces, copper iron, plain steel and copper steel, to determine their resistance to sulphuric acid corrosion. Specimen sheets were tested 60 days in each case, either alone or fastened to sheets of pure iron by copper rivets or iron rivets, forming galvanic couples.

The Gap Between Theory and Practice in the Production of Corrosion-Resisting Iron and Steel, William D. Richardson. Thirty-Ninth Gen. Meeting, Am. Electrochemical Soc., April 21–23, 1921, advance paper no. 16, pp. 147–165. Electrolytic theory of corrosion is discussed, also influence of oxygen and role of adhering rust. Accelerated corrosion tests are studied, and their defects pointed out. Behavior of copper-bearing iron, silicon-containing cast-iron, nickel and nickel-chromium steels, nickel-copper steels, chromium steels, and nickel-cobalt-chromium alloys is investigated.

Magnet. See MAGNETS, Steel for.

Metallography. The Metallography of Low Carbon Steel, James Mitchell. Jl. West of Scotland Iron & Steel Inst., vol. 28, part 4, Jan. 1921, pp. 38–45 and (discussion) pp. 45–49, 27 figs. on 4 supp. plates. Interpretation of photomicrographs.

Structural. See STRUCTURAL Steel.

Testing. The Testing of Steel, D. Sillars. Foundry Trade Jl., vol. 23, no. 240, Mar. 24, 1921, pp. 268–270. Comparative value of tests ordinarily applied.

Tests. Experimental Investigations of the Behavior of Wrought Iron and Low-Carbon Steel at Freezing Temperature under Sudden Stress (Versuche über das Verhalten von Schweisseisen und Flusseisen in der Kälte bei plötzlicher Beanspruchung), Ed. Wilh. Kaiser. Stahl u. Eisen, vol. 41, no. 10, Mar. 10, 1921, pp. 333–337, 8 figs. Under sudden stress influence of freezing temperature on both wrought iron and low-carbon steel is considerable. With cooling off to 20 deg. cent., low-carbon steel loses about 85.5 per cent, wrought iron only 42.3 per cent.

STEEL CASTINGS

Centrifugal Process. Tests of Centrifugally Cast Steel, George K. Burgess. Trans. Am. Soc. for Steel Treating, vol. 1, no. 7, April 1921, pp. 370–382, 26 figs. Photomicrographic examination of castings made by Millsbaugh centrifugal processes.

Tests of Centrifugally Cast Steel, George K. Burgess. Iron Age, vol. 107, no. 12, Mar. 24, 1921, pp. 764–766, 5 figs. Results suggested possibility that centrifugally cast steel suitably treated may rival properties of forgings of same chemical composition.

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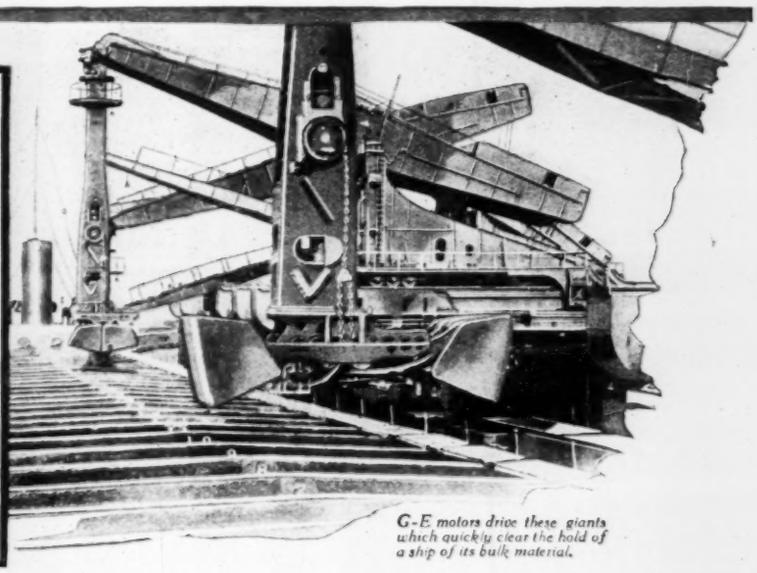

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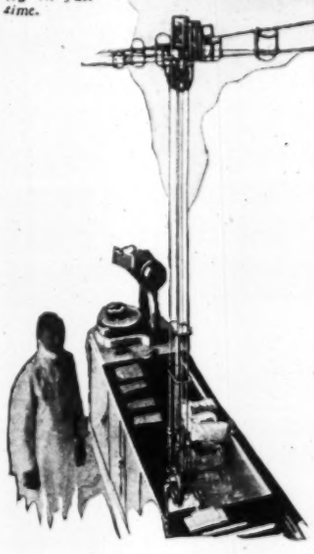

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